CAWSES News

Climate And Weather of the Sun-Earth System

Volume 4, Number 1 **March 2007**

CAWSES is an international program sponsored by SCOSTEP (Scientific Committee on Solar-Terrestrial Physics) and has been established with the aim of significantly enhancing our understanding of the space environment and its impacts on life and society. The main functions of CAWSES are to help coordinate international activities in observations, modeling and theory crucial to achieving this understanding, to involve scientists in both developed and developing countries, and to provide educational opportunities for students at all levels.

Message from the Chair

S. Avery (susan.avery@colorado.edu)

Scientific and capacity building workshops, planning activities in conjunction with IPY and IHY, observational campaigns, and the first CAWSES Virtual Conference are some of the major CAWSES activities during these past six months. The variety and quality of these activities is exciting and is leading to new science – new approaches to calibrating solar activity over time, enhanced observations to understand the evolution of "super-substorms", first results from the Japanese solar satellite Hinode, and progress in space weather modeling with its potential for operational predictions. Additional capacity building workshops and schools have been held on promoting the use of data from GPS constellations, space weather modeling, and atmospheric radar. New capacity building workshops are being planned including one that will be held in Ethiopia this coming November. This newsletter has a wealth of information on all of these activities.

One of the major upcoming events is the International CAWSES Symposium to be held during October 23-27, 2007 in Kyoto, Japan. The symposium will highlight the research results from all CAWSES Themes. It will be an opportunity for all of us to get together in a beautiful historic location to share what we have been able to accomplish through this international collaboration. And it will be the time that we share plans for the follow-on program to CAWSES.

CAWSES has been focused during a period of quiet solar activity and many scientists feel that it is important to have a CAWSES-2 project during the next phase of the solar cycle; progress towards space weather modeling and the applications of that modeling to real-time prediction are becoming possible; solar variability and its impact on climate and the space environment are receiving renewed attention in the policy area; and the success of the Virtual Conference suggests that it might be time to increasingly use digital tools to remain connected and networked in new ways. All of these ideas and more are going to be considered in the planning of CAWSES-2. SCOSTEP has established a planning committee and together with the Theme leaders we will work to have a set of draft ideas ready for the SCOSTEP Bureau meeting on July 7th in Perugia. The planning group will do most of the work via email and have a one day meeting in Perugia on July 1st.

In the meantime, please enjoy this newsletter and I hope to see all of you this October in Kyoto!

Developments in CAWSES Activities Since September 2006

D. Pallamraju (raju@cawses.bu.edu)

We have entered the 4th year of the CAWSES program. The continued enthusiasm and participation of all of you has taken the CAWSES program from a concept to great new means of interaction to address global science issues that need participation from one and all. The great success of the CAWSES Virtual Conference held in November last year stands as a testimony to the new pathways that CAWSES is taking in order to involve wider participation. Figure 1 illustrates the international nature of the participation, which has exceeded all expectations. The initially announced duration of the conference 13-22 November was therefore extended for a few more days (27-30 November). By the final day, the conference had logged 270 registered participants and a total of more than 120,000 hits to the Virtual Conference website! (Figure 2). Please read Janet's article below for some of the salient features of this conference and some preliminary results.

Figure 1: Remarkable worldwide participation in the Virtual Conference [after Barnes et al., 2006]

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Inside this issue:

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We have an insightful article in Leif Svalgaard's contribution on using magnetic declination angle to trace back the solar activity for the past 160 years and more! A detailed article on the above topic is available on the CAWSES webpage. In this issue you will also find reports on the progress of CAWSES science in various countries. The CAWSES Space weather modeling workshop held in Kyoto last November was a great success and several papers from it will form a special issue in Journal of Geophysical Research. Capacity building activity continues through CAWSES/SCOSTEP support to various conferences, schools and through the CAWSES-AOPR office in Taiwan.

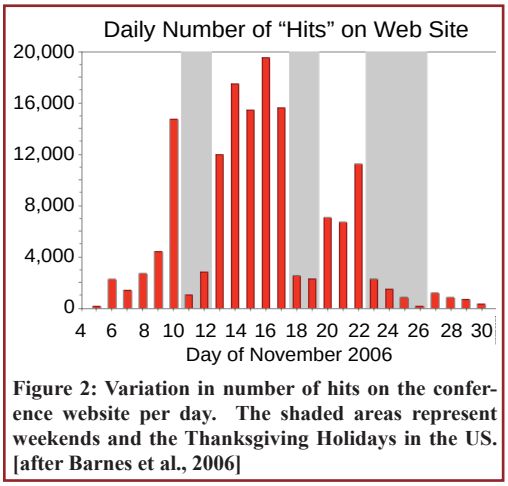

Figure 2: Variation in number of hits on the conference website per day. The shaded areas represent weekends and the Thanksgiving Holidays in the US. [after Barnes et al., 2006]

Several exciting CAWSES events and conferences have been lined up for this year. They begin with the CAWSES Workshop on comparative study of solar flares and magnetospheric storms in March. There are special CAWSES science sessions planned in the EGU and AGU meetings in April and May. The 2nd and 3rd CAWSES Tidal Wave campaigns are planned for Mar 1 – Apr 30 and Jun 1 – Aug 15. The 2nd CAWSES Global Tidal workshop and the International CAWSES Symposium will be held in Aug 27 – 30 and Oct 23 – 27. Boosted by the success of the 1st Virtual Conference, plans are on to hold a second one during the summer of this year. Please stay tuned for more information on all these activities. As always, I take this opportunity to solicit your participation in the CAWSES observational campaigns and to share your science results in CAWSES sessions.

Barnes, R J, J Kozyra, M Weiss, N J Fox, D Morrison, L Paxton, Implementing a Virtual Workshop for Interdiscplinary collaboration on Grand Challenge Issues: Lessons Learned, Eos Trans. AGU, 87(52), Fall Meet. Suppl., Abstract SA43A-02, 2006

From the SCOSTEP Office

G. Lu (ganglu@ucar.edu)

Our next SCOSTEP Bureau Meeting will be held in Perugia, Italy during the IUGG XXIV General Assembly at the Hotel Gio on July 7. The SCOSTEP General Council Meeting will be held at the same venue on July 8. The election results for SCOSTEP President and Vice-President will be announced after the General Council Meeting.

CAWSES Global Tidal Campaigns and Workshops in 2007

W. Ward (wward@unb.edu)

Two CAWSES Global Tidal campaigns will be held this year. These are expected to help 1) identify and stimulate observations which will contribute to our understanding of the migrating and the non-migrating atmospheric tides, their sources, their propagation characteristics, and impacts throughout the atmosphere, and 2) stimulate interactions between scientists and analysis of these observations.

2nd CAWSES Tidal Campaign: Mar 1 to Apr 30, 2007
3rd CAWSES Tidal Campaign: Jun 1 to Aug 15, 2007

2nd Global Tidal Workshop will be held in Newbrunswick, Canada during August 27 – 30, 2007. In this workshop participants will be involved in direct analysis of data from various types of observations to identify the global tidal structures present. In particular, we will be interested in examining whether the global structures from different observation types are consistent with each other and comparing these structures to those identified in general circulation models.

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Awards in the CAWSES Community

Umran Inan has been elected Fellow of the American Geophysical Union in 2007. We congratulate him on his well-deserved recognition.

Progress Under CAWSES Themes

Theme 2: Space Weather: Science and Applications

CAWSES Sun-Earth Connections Virtual Conference Series: First Results

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Motivation for the Virtual Conference Series

Fifty years after the International Geophysical Year (IGY), the complexity of the Sun-Earth system continues to offer challenges to exploration and our understanding. Discoveries are increasingly found at the intersection and boundaries between regions. Science questions span multiple regions or, at times, the entire system of Sun-to-Earth. Continuing progress demands new ways of doing science on a global scale. As a response to these challenges, a new form of scientific communication, the Virtual Conference, has been explored by CAWSES Space Weather Theme as a tool for enhancing scientific collaboration worldwide: (1) to address grand challenge science issues that require the combined expertise of multiple disciplines and the synthesis of data sets worldwide for progress, (2) to support multi-disciplinary and interdisciplinary collaborations, (3) to promote science capacity building in developing countries, (4) to provide a resource for students worldwide, and (5) to celebrate the 50th anniversary of IGY.

Basic Elements of a Virtual Conference

To support this effort, a virtual conference environment was developed through collaboration between the CAWSES program and Johns Hopkins University Applied Physics Lab (JHU-APL). It has elements similar to a face-to-face conference but takes place completely over the Internet. The plan is to design each conference around a single Sun-to-Earth science topic to provide a common focus for all disciplines and highlight common threads. Presentations are text- and graphics-based and asynchronous to be accessible to a worldwide audience regardless of time zone and bandwidth. Sessions are used to focus discussions around science topics. A data commons area contains conference data products, shared resources and links to cyber-infrastructure including virtual observatories, runs-on-demand of community models, advanced visualization, etc. Discussions take place on message boards attached to: individual papers, sessions and conference-level overview topics. A key element is the use of moderators to encourage, clarify and integrate discussions that take place on message boards, and importantly to "weave together" the inputs from the conference participants into a global perspective. These system-level insights are the primary output. The conference is archived for ongoing collaborations and future reference.

The Kickoff Session

Joining CAWSES in this effort were a number of sponsors and scientific advisors including IHY, eGY, ICESTAR, NASA/LWS, NSF Atmospheric Sciences, and originators of the Solar Extreme Event workshop series. The exciting results that follow provide an intriguing glimpse into the potential in this type of virtual interaction. <http://workshops.jhuapl.edu/s1/index.html>

Remarkable Worldwide Participation

The Virtual Conference is a very different medium than a face-to-face conference with strengths that appear particularly well suited to support interdisciplinary worldwide interactions. The properties of the Virtual Conference enable maximum participation across disciplines and nations, easy sharing of information, more time to pose thoughtful questions and supply well-considered answers, ability to "attend" presentations in all discipline areas, and new opportunities to explore interesting collaborations across disciplines and nations. At the peak of the conference, on any given day, there were visits from some 120 unique IP addresses (Figure 1). This figure along with Figures 1 & 2 in Pallamraju's editorial and comments collected from participants during the first Virtual Conference test bed demonstrate the significant potential in this type of medium and it will be used to improve the conference capabilities as follow-on interactions continue. One particularly promising area for future interactions is the combined use of small face-to-face workshops that interact with the Virtual Conference to provide an in-depth exploration of key topics within the broader context provided by the virtual interaction.

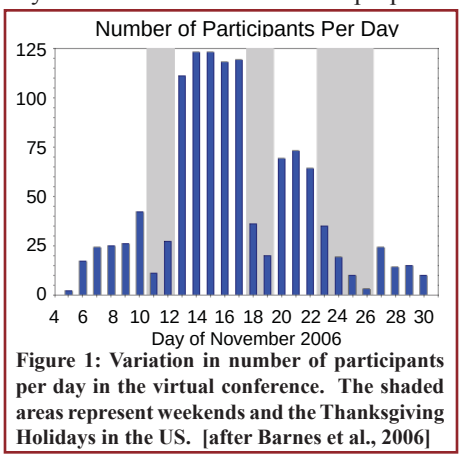

Figure 1: Variation in number of participants per day in the virtual conference. The shaded areas represent weekends and the Thanksgiving Holidays in the US. [after Barnes et al., 2006]

The Grand Challenge for the 1st Conference

In 2005, the IMAGE and TIMED spacecraft watched the development of large-scale auroral spirals on the dawnside of the auroral oval and long-duration finger-like (unclosed spiral) structures on the duskside in the southern hemisphere during intense substorms in the main phase of severe magnetic storms on 15 May and 24 Aug. Because of this association and until our understanding deepens, these events will be referred to as super-substorms. Figure 2 gives nearly simultaneous views of the dawnside feature by TIMED and IMAGE [Kozyra et al., VC, 2006]. To our knowledge, these large-scale dawn and dusk spirals have not previously been identified as a systematic feature of auroral substorms. In fact, these spirals are absent during substorms occur-

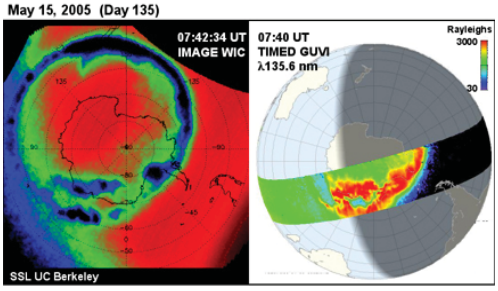

Figure 2: Large-scale dawnside auroral spiral during a substorm in the main phase of a superstorm on 15 May 2005 observed nearly simultaneously by the IMAGE and TIMED spacecrafts in the southern hemisphere. [after Kozyra et al., VC, 2006]

ring at other phases of the superstorms on these same days, which do not show any dramatic activity in the dawn or dusk sectors. Similar structures have now been found during substorms in the main phases of 6 other superstorms that occurred between 2000 and the present.

The solar source regions that produced the May and Aug 2005 super-substorms also had interesting features. Both source regions were complex active regions in close proximity to open flux regions as can be seen in Figure 3. This close proximity has been proposed to enhance the geoeffectiveness of CMEs released in eruptions [c.f., Gonzalez et al., 1996]. The source of the 15 May event was a sigmoid active region [Lee and Lui, VC, 2006; Yurchyshyn VC, 2006] and of the 24 Aug event: an "anemone" active region surrounded by a coronal hole [Asai et al., VC, 2006].

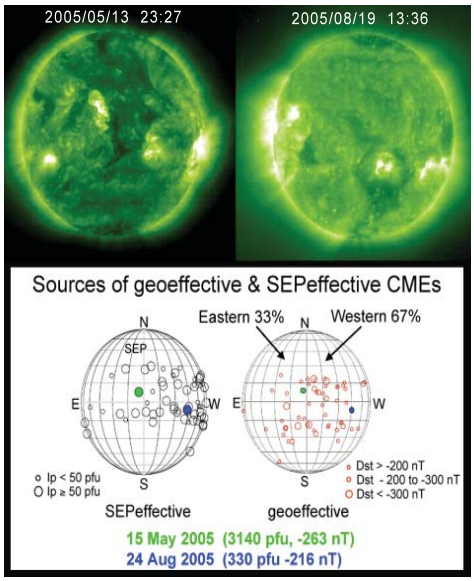

Figure 3 Active regions that produced the severe magnetic activity on 15 May and 24 August 2005 were both in close proximity to open flux regions. The relation between the location of the CMEs on the solar disc and its geo-effectiveness have been put into context by Gopalswamy et al., (VC, 2006). Images courtesy of SOHO/EIT.

New Results about the Global Sun-Earth System

Observations from 19 different scientific satellites and numerous ground-based instruments provided a reasonably complete picture of conditions throughout the Sun-Earth system. Satellites participating in the conference were: ACE, Akebono, CLUSTER, DEMETER, DMSP, Double Star, EOS MLS, Geotail, GOES, IMAGE, Iridium, LANL GEO, NOAA POES, Polar, RHESSI, SOHO, TIMED, TRACE and Wind. Ground-based observations consisted of GPS receivers, SuperDARN radar, incoherent scatter radars, MF radars, Fabry-Perot interferometers, scintillation observations, ionosondes, magnetometers, solar vector magnetograms, solar H-alpha images and solar radio observations.

We started out with a set of general questions, which have been expanded and refined by the discussions and presentations in the first Virtual Conference. The set of new questions (listed below) will be used to design the follow-on virtual interaction.

- What is the nature of super-substorms? Are they really substorms at all?
- Are there similarities between the features of super-substorms and those of double-ovals seen during substorms outside of magnetic storms [Elphinstone et al., 1995] by Viking? How are the features reported here related to reports of auroral spirals by Anger and Lui [1973] and Davis and Hallinan [1976]?
- What are the roles of omega bands and narrow north-south auroral structures in the formation of the dawn and dusk spirals?
- Is there evidence for the rolled-up Kelvin-Helmholtz vortices at the magnetopause during super-substorms? Such vortices during northward IMF have been shown to produce entry of boundary layer plasma into the magnetosphere due to reconnection between anti-parallel fields that develop during that time. Results of numerical experiments (example in Figure 4) using the BATS-R-US MHD model [Kuznetsova et al., VC, 2006] indicate that such vortices might also occur during southward IMF at times of unusual flow conditions (marginal Alfven Mach number 2-3). Such flow conditions are typical of the main phase of superstorms [Borovsky, VC, 2006]. It is possible that the onset of these vortices may introduce a new pathway for boundary layer plasma to enter the magnetosphere and populate the plasma sheet changing the geospace response to the extreme solar wind driving.

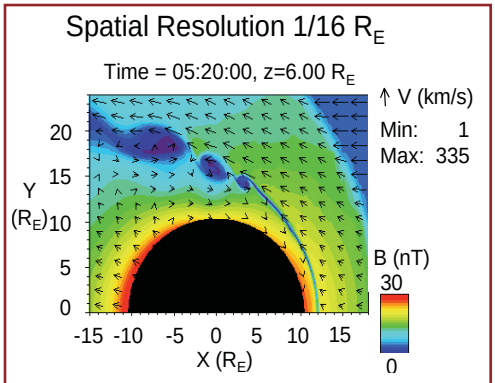

Figure 4 Numerical experiments with the BATS-R-US MHD model indicate that the magnetopause is unstable to the formation of non-linear Kelvin-Helmholtz vortices during southward IMF and marginal Mach number (MA ~ 2-3) flow conditions in the solar wind [Kuznetsova et al., VC, 2006].

- Is there evidence for emergent processes throughout geospace that reflect changes in the geospace state? An incomplete list of candidates include: (1) dawnside ionospheric flow vortices [Oksavik et al., VC , 2006], (2) unusual intense EMIC harmonic waves in the outer plasmasphere [Parrot et al., VC, 2006], (3) earthward penetration of ULF waves [Dent et al., VC, 2006], (4) possible signatures of the precipitation that forms the auroral spirals in total electron content maps [Coster et al., VC, 2006].
- Does the proximity to open flux regions enhance the geoeffectiveness of CMEs that are released from the solar source regions?
- Why is the CME released on 22 Aug 2005 geoeffective despite its west limb location?
- Why is the SEP event stronger in the 13 May 2005 eruption than in the 22 Aug 2005 eruption despite a disc center compared to west limb location?
- What features in the solar source regions are responsible for producing marginal Alfven and magnetosonic Mach number flow conditions in the solar wind?

We would like to express our special thanks to the organizers, science advisors, developers of the Virtual Conference environment at JHU-APL, the moderators of the Virtual Conference discussion boards, collaborating organizations and the participants who were willing to be pioneers in this experiment. A follow-on interaction is in the planning stages. A special collection of journal articles summarizing the results will be the final product. A more detailed summary on the Virtual Conference is available at http://workshops.jhuapl.edu/s1/summary/index.html.

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1971, Planet Space Sci., 21, 873-878, 1973.
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Theme 4 : Space Climatology

Progress in Solar Irradiance Variability Group of Theme 4

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The scientists of this Working Group are closely involved with PICARD mission and with organization of a workshop "Solar Variability, Earth's Climate and the Space Environment" to be held in June 2008.

PICARD is a mission under the responsibility of the French Space Agency (CNES). Its objectives are to improve our understanding of the functioning of the Sun through new measurements and the influence of the solar activity on the climate of the Earth. For that, simultaneous measurements of the absolute total and spectral solar irradiance, diameter and solar shape, and oscillation modes (helioseismology) for probing the Sun's interior will be carried out. These measurements obtained all along the duration of the mission will allow the study of their variations as a function of the solar activity. The payload consists of three instruments provided by Belgium, France, and Switzerland. There are two independent radiometers for measuring the total solar irradiance, sun photometers providing data in several spectral domains and an imaging metrological telescope dedicated to helioseismology and solar diameter measurements. Presently, space instruments are in construction after validation of their concept. In parallel to the instrumental activity, the PICARD Scientific Data Processing Center is being developed. The launch is expected to be in March 2009 on a sunsynchronous orbit.

One of the major activities for CAWSES Theme 4, WG 1 in recent past has been to finalize on a Workshop "Solar Variability, Earth's Climate and the Space Environment" which will be held during Jun 1 - 6 2008 at the Montana State University in Bozeman, Montana, USA. The workshop is sponsored by SCOSTEP/CAWSES and co-sponsored by IHY, Montana State University, NASA, the Goddard Earth Sciences and Technology Center, and University of Maryland Baltimore County. Related to the meeting a book proposal was submitted to Cambridge University Press and an agreement between the book editors and Cambridge is in process, after the proposal was accepted by Cambridge. Please visit http://solar.physics.montana.edu/SVECSE2008/index.html or contact Judit Pap (Judit.M.Pap.1@gsfc.nasa.gov) or Dibyendu Nandi (nandi@mithra.physics.montana.edu) for additional information.

Calibrating the Sunspot Number using "the Magnetic Needle"

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George Graham (1724) discovered that the direction (called the Declination angle today) of the horizontal component of the Earth's magnetic field varies systematically during the day. The movement is only a few minutes of arc, but it can be easily measured. The origin of these deflections is the combined magnetic effects of ionospheric current systems flowing in the E-region and of induced "telluric" currents created by dynamo action. These systems consist of two vortices, one in each hemisphere, with foci at ~30º latitude and ~1 hour before local noon, both comprising of two currents; one flowing above the Earth's surface and the other one (in the opposite direction) underneath the surface. These currents, fixed in space in relation to the Sun, flow at all times giving rise to the mostly regular daily variation discovered by Graham, called SR variation. The current intensity and the size of the vortices change with seasons, with the largest in the summer hemisphere. Along the 'flanks' of the (external) vortices, the current flow is equatorwards on the morning side and polewards on the afternoon side. The magnetic effect at mid-latitudes of these currents at a right angle to the current flow is thus the East-West (or Y). This is a suitable proxy for the strength of the SR ionospheric current system.

Figure 1 shows the daily variation of the East component of the geomagnetic field at Hobarton (Tasmania, 42.9º S) for the year 1848. We can define the range rY (in nT) as the yearly average peak to valley difference. Note the seasonal variation of the amplitude of the diurnal variation. By averaging over a year, the seasonal variation evens out and minor season-dependent shifts and irregularities are minimized. We have reliable measurements like the one shown above for many observatories (the number ranging from a handful in the 1840s to more than a hundred in the 21st century). Selecting mid-latitude stations, one finds that the diurnal range, rY, for each year does not vary much (less than a factor of two) from station to station (partly caused by varying underground conductivity). Using overlapping data we normalize the yearly values of rY for each station to that of the Niemegk station in Germany and plot the average 'global' range as a function of time in Figure 2.

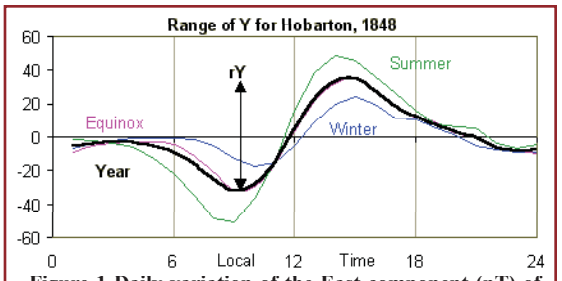

Figure 1 Daily variation of the East component (nT) of the geomagnetic field at Hobarton for the year 1848.

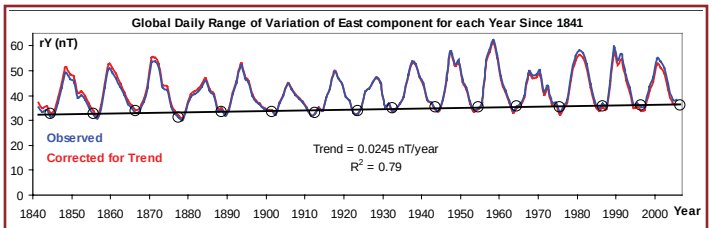

Figure 2 The average yearly range, rY, of the daily variation of the East component of the horizontal force (blue), corrected for secular trend (red).

The circles show rY averaged over the three years around each sunspot minimum. There is a clear trend in these values (0.0245 nT/year) amounting to an increase of 9.8% over the 166-year interval 1841 - 2006. The red curve shows the ranges with this trend removed. It is likely that the increase simply results from an increase of the ionospheric conductivity caused by the 9% decrease in Earth's main dipole field over the same time interval. Simple theory predicts that the conductivity should be inversely proportional to the ambient magnetic field strength.

Of special interest to us for this article is the clear solar cycle variation of rY. This was noted already by the earliest observers of the sunspot cycle and geomagnetic variations (Sabine, Wolf, Gauthier, Lamont) around 1850. Rudolf Wolf codified the relationship by a linear relation rD = a + b RW, where rD was the range of the Declination measured in minutes of arc (rather than the range of the Y-component in nT) and RW was the 'Wolf" number given by RW = k(10 g + f), where g was the number of sunspot groups, f the number of spots, and k a calibration factor. Wolf observed sunspots from 1849 until his death in 1893. By 1861, he was able to publish yearly sunspot numbers from 1749 through 1860 (Wolf, 1861). In the following years, Wolf also collected data on rD from observatories all over the world and became more and more convinced of the basic validity of his linear relation. In fact, in his yearly reports on the sunspot number he never failed to compare the observed yearly values of rD with the value calculated from his relationship and always found "good agreement", thus validating the sunspot number against an independent observable. So strong had the confirmation become that Wolf around 1880 quietly revised his sunspot series by increasing the pre-1849 values by ~20% to bring them into better agreement with the geomagnetic record. Later researchers did not share Wolf's enthusiasm for his relationship. With our modern understanding we realize that the relation is sound except that the proper variable to use is the East-West deflection, rY in force-units (nT), having a direct physical interpretation in terms of current intensity.

The current intensity in turn depends on the ionospheric conductivity. The F10.7 cm radio flux has been shown to be a good proxy for the FUV flux causing most of the ionization. We should then expect a good correlation between rY and the F10.7 flux (available since 1947). This is indeed the case with high fidelity (F10.7 = 5.95 rY - 127.7; correlation coefficient 0.99). We can now calculate F10.7 from rY using this regression. In a sense, the good correlation is a validation of the idea that F10.7 is a good proxy for the FUV emission, and is also a validation of the mechanism behind Wolf's relationship using rY instead of rD.

We can thus reconstruct the F10.7 radio flux as far back as we have rY data (to 1740 with some gaps). Because there is also a good correlation between the F10.7 radio flux and the sunspot number, we expect a good correlation between rY and Rβ, β might be any of I (International from 1981), Z (Zürich, 1749-1980), or G (Group, 1610-1995). Assuming that the international sunspot number, RI, after 1980 has a uniform definition and calibration, we find the relation RI, = 6.97 rY - 185. The correlation is just as good as for F10.7, 97% of the variation matches that of rY. If one correlates other subsets of the sunspot series, one finds similar correlations, but the regression constants are different. This suggests that the sunspot series does not have calibration that is constant in time. As the definition of the sunspot number is arbitrary and the counting process somewhat subjective, there is no 'correct' sunspot number. It seems most practical to adopt the International Sunspot Numbers since 1981 as the base for any standardization. Using then the regression equation for RI, we calculate RI from rY since 1841. The result (blue curve) is shown in Figure 3. Also shown are yearly averages of observed RI, or RZ (red) and RG (purple).

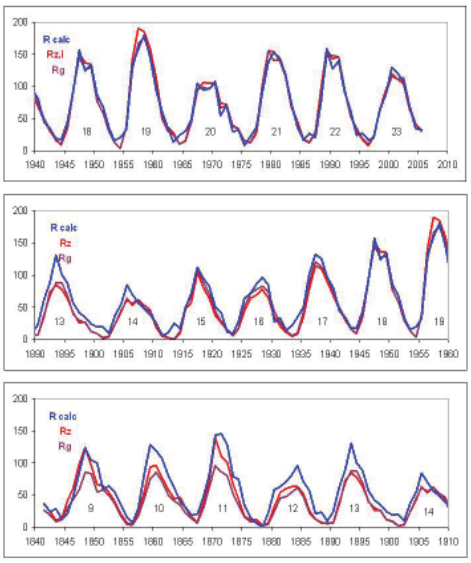

Figure 3 Calculated (blue curve) yearly average RI from rY since 1841. Observed yearly averages of RI, or RZ (red) and RG (purple) are shown for comparison. Note the overlap between panels.

It is evident that the observed sunspot numbers generally match our reconstructed sunspot numbers back to the mid-1940s, but that the observed sunspot numbers generally fall below our reconstruction earlier than that; the difference increasing as we go further back in time. The difference is largest for the Group sunspot numbers, at times as large as 50%.

It is clear that the differences between the calculated sunspot number and the two observed series vary with time. No single trend is apparent, so we opt for finding a correction factor separately for each cycle by fitting the reconstructed and observed values by a straight line through the origin. We thus de-emphasize the influence of just the maximum value and spread the correction evenly (in the least-squares sense) over the entire cycle.

We now construct a set of correction factors for each series (RZ and RG for each cycle to be applied to each year (stipulating the same factor for monthly and daily values) within the cycle. That is, we assume that the calibration is constant within a cycle. This can, at best, only be an approximation to the truth, but can be justified by the finding that none of the correlation plots for any of the other cycles show any clear jumps or other signs of a mixture of two populations with different calibration.

The counting method for small spots changed in 1893 when Wolf died and his assistant Wolfer carried on the series, and in 1945 when Waldmeier took over. These changes seem to be duly reflected as discontinuities in the inferred correction factor for the Zürich sunspot number. It is not clear why the Group Sunspot Number (GSN) calibration changes. If we were to entertain the view that RG is so simple to measure that it has to be correct, then we must accept that rY must either be in error by more than 50% or that our interpretation of the cause of rY is seriously incomplete. It must be remembered that rY is also easy to measure. Wolf was correct in insisting that the geomagnetic effects should track the

sunspot numbers according to some relation with a physical interpretation.

We can now plot (Figure 4) the corrected sunspot number series since cycle 9. There is no real difference between the corrected GSNs and Zurich sunspot numbers. The curves fall on top of one another. It is of interest to note that (corrected) cycles 11 and 10 were as active as the most recent cycles 22 and 23. We thus see no evidence in the sunspot number of a secular increase in solar activity over the last ~165 years.

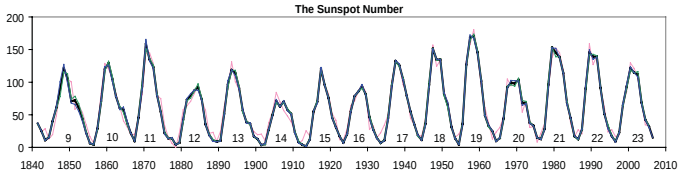

Figure 4. Corrected yearly average sunspot numbers 1841-2006 consistent with the long-term variation of the daily range of the geomagnetic East component.

Conclusion: What is one to make of this? Already the fact that the Zürich and the GSNs are different before ~1875 should give pause. That neither of them is consistent with the observed variation of the daily range of the geomagnetic SR variation might be a hint that the debate is not which of the two to use but how to reconcile the observations into a consistent dataset. We suggest that careful analysis of geomagnetic data (extending back into the 1740s) could be a possible approach to securing the calibration of solar activity over time, which has taken on a new importance as an element in the debate over climate change. A more detailed article on this topic can be accessed from on the CAWSES website (http://www.bu.edu/cawses/cawsesnews.htm).

[1] Graham, G. (1724) An Account of Observations Made of the Variation of the Horizontal Needle at London, in the Latter Part of the Year 1722, and Beginning of 1723, Phil. Trans. Roy. Soc., 33, 96-107, doi: 10.1098/rstl.1724.0020.
[2] Wolf, R. (1861) Abstract of his latest Results, M. Notices Roy. Astron. Soc., 21, 77.

Capacity Building and Education

Report on the Second Capacity Building Workshop on Space Science, in Taiwan, in October – November 2006

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The Second Capacity Building Workshop on Space Science was held from Oct 30 to Nov 8 in the campus of National Central University (NCU), Taiwan. The workshop was organized by CAWSES-AOPR coordinating office with funding support from National Science Council of the Republic of China in Taiwan. The purpose of the workshop was to promote usage of atmosphere-ionosphere data obtained by recently launched FORMOSAT-3/COSMIC satellite constellations. A constellation of 6 satellites was put into low-Earth orbit in April 2006 to collect data of atmospheric humidity and temperature profile below an altitude of 100 km as well as the ionospheric electron density profile above 100 km. The horizontal ionospheric density variation is also included in the dataset. Since the dataset is open to the public, it should be valuable for scientists in countries that do not have their satellites for observation of space phenomena. Out of the 35 applications received we could select 31 participants with the available funds. The participants came from Indonesia, Philippine, Thailand, and Vietnam. It is hoped that in the 3rd workshop there will be presentations on some results by participants of the previous workshops using data from FORMOSAT satellite series. The 3rd workshop will be held in October of 2007 at NCU again. Further details of that workshop will be announced through the CAWSES mailing list and in the September 2007 issue of the *CAWSES News*.

Report on the International School on Atmospheric Radar, Taiwan, in October 2006

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Considering the continuing international development of atmosphere and ionosphere radar and space science and the requirement to help newcomers, young students, and researchers to get acquainted to these fields, the National Central University (NCU) in Chung-Li, Taiwan offered to hold a school on these subjects. The International School on Atmospheric Radar (ISAR) was held during 9 – 27 Oct 2006 under the main sponsorship of NCU in Chung-Li, Taiwan, with support from the National Science Council and the Ministry of Education of the Republic of China, Taiwan. The school was also sponsored by SCOSTEP/CAWSES and URSI. Out of the 80 applications received, a total of 23 students were selected from Brazil, India, Indonesia, Taiwan, and the USA. All foreign students received financial support for travel and the local accommodation was provided by NCU. The school performed under the local organization of C. J. Pan and colleagues and the international organization was done by J. Röttger supported by several lecturers. The lecture program of ISAR-NCU had been developed well in advance, following the course outline of former schools of this kind. It covered the following main topics: fundamentals of ionospheric and atmospheric radars, principle of the MST radar technique, scattering and reflection processes from the clear and cloudy air, radar antennas, interferometry, transmit-receive systems, radar control, MST radar signal acquisition and pre-processing, radar wind profilers, MST radar meteorology, precipitation scatter, coherent scatter from the ionosphere, ionosonde measurements, GPS occultation methods, a detailed description of the hardware, the operation and data analysis of the Middle and Upper Atmosphere Radar in Japan, the Equatorial Atmosphere Radar in Indonesia and the upgraded and renovated Chung-Li VHF Radar. Three public lectures were given on the historical development of the Chung-Li VHF Radar and the Indian National MST

Participants at ISAR-NCU. Photo courtesy of J. Röttger

Radar in Gadanki, both resulting from the initiatives of the Middle Atmosphere Program in the 1980s. The opening and closing sessions were attended by the President of the NCU Prof. L. C. Lee, the Chancellor of the University System of Taiwan, Prof. C. H. Liu, Vice President Prof. W. Ip, the Dean of the College of Earth Sciences Prof. B. F. Chao amongst others. All expressed their high appreciation on the performance of the ISAR at NCU. The President indicated his enthusiasm to strongly support this kind of schools in the future at NCU.

Reports from the CAWSES Community

CAWSES - Brazil

Brazilian CAWSES Activities During 2006

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There are four institutions involved in the SCOSTEP's CAWSES program in Brazil: National Institute for Space Research (INPE), Center for Radio Astronomy and Astrophysics, University of Mackenzie (CRAAM), National Observatory (ON), University of Vale do Paraiba (UNIVAP). Although there was no CAWSES related financial back up from local government, each institution has been taking its own initiative to carry out a specific subject of their interest related to the CAWSES program. Brief activity report is as follows:

Theme 2 (Space Weather: Science and Applications)
ON is developing a project for the Brazilian network of geomagnetic field observation, REBOM (Rede Brasileira De Observatorios Magneticos). Under this project, 5 more automatically operating magnetometers will be installed. Contact: Irineu Figueiredo (irineu@on.br)

Theme 3 (Atmospheric Coupling Processes)
INPE conducted two observational campaigns for studying dynamical coupling processes from the mesosphere to the ionosphere, during Mar - Apr and Sep - Nov, 2006. The main goal was to look for a possible relationship between the Spread-F occurrence and the mesospheric gravity wave activity. The second campaign was carried out with the participation of the research group coordinated by D. Fritts from CORA, USA. Digital ionosonde and VHF coherent radar at São Luís (2.6° S, 44.2° W), Digisonde at Fortaleza (3.9 S, 38.4 W), Meteor radar and imager at São João do Cariri (7.4° S, 36.5° W), digisonde and imager at Cachoeira Paulista (22.7° S, 45.0° W), and imagers at São João da Aliança (14.8° S, 47.6° W) have been operated. Analyses of all ionospheric and mesospheric data are under progress. Some preliminary results are planned to be presented in the upcoming CPEA symposium at Kyoto University during Mar 20-23, 2007 and in the IUGG meeting at Perugia to be held during Jul 2-13, 2007.

UNIVAP has a digital ionosonde, an all sky optical camera and a GPS receiver system in order to carry out coordinated observations around equatorial and low latitudes: **I.** Network of three digital ionosondes (CADI) are operating on a routine basis at S. J. Campos (23.2° S, 45.9° W), Palmas (10.2° S, 48.2° W), and Manaus (2.9° S, 60.0° W), **II.** Network of three multi-spectral (OI 777.4 nm, OI 630.0 nm, OI 557.7 nm, NaD 589.3 nm, O2 (0-1) 864.5 nm, OH several bands, N2+ 427.8 nm) all-sky imaging systems are operational; two on a routine basis at Palmas and Brazopolis (22.5° S, 45.5° W), while one system is at S. J. Campos and is operated in a campaign mode, **III.** Network of five GPS receivers are operating; one GPS receiver at S. J. Campos since Oct 2006, four more have been procured for routine operation at Brazopolis, Palmas, Manaus and Ji-Parana (10.9° S, 63.3° W). Contact: Paulo R. Fagundes (fagundes@univap.br).

CRAAM is developing the South America VLF NETwork (SAVNET) of several VLF receivers spread over the Central and South American territory in order to study the long-term effects of the solar radiation and its time variations on the Earth's atmosphere. They have found that the low D-region is more sensitive to solar radiation during epochs of minimum solar activity. Contact: Jean-Pierre Roulin (raulin@craam.mackenzie.br).

Theme 4 (Space Climatology)
ON has been monitoring the variation in the solar diameter using Heliometer data. Results from these studies have been presented in the IAU meeting in Prague in August in addition to other conferences and have also been submitted for publication in the Journal of Solar Physics.

CRAAM has been involved in research on the solar energy release during flares observed at high frequencies (200 - 400 GHz), leading to new ideas on the interpretation of submillimeter-wave and microwave flare radiations. Plans have been made to observe solar flares at even higher frequencies in the infra-red range and first observations of rapid energy releases were found. A new cosmic ray detector device has been recently installed at El Leoncito Astronomical Complex (CASLEO), which will allow studies on the modulation of the cosmic ray fluxes on different timescales related to the solar (magnetic) cycle of 22 years and on transient events of shorter scales associated with solar flares and Coronal Mass Ejections.

CAWSES - China

Progress Under CAWSES Space Weather Theme in China

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International Space Weather Meridian Circle Program: The Meridian project (originally proposed by Professor Wei Fengsi and colleagues at Center for Space Science and Applied Research) is a Chinese multi-station chain along 120º E to monitor the space environment, starting from Mohe (the most northern station in China) through Manzhouli - Harbin – Changchun – Beijing – Xinxiang – Wuhan – Guangzhou and extended to the Chinese Zhongshan station in the Antarctic. Meanwhile, the north-latitude 30º N station chain from Shanghai in eastern China through Wuhan, Chengdu to Lasa (Tibet) station in western China will be involved in this monitoring system. Accompanying the Meridian project, Chinese Scientists suggested an International Space Weather Meridian Circle Program (ISWMCP) to establish a complete meridian circle connecting 120º E to 60º W in order to enhance the ability to monitor space environment. To promote international cooperation for this program, two conferences were held (at Sanya in Jan 2003 and at Beijing in Oct 2006). Now the project is entering its implementation period from 2007 to 2009. For other details, please contact Quanlin Fan (qlfan@spaceweather.ac.cn).

Pre-study of KuaFua Mission: Kuafu mission includes three Satellites (1 at L1, 2 Polar orbiting satellites) proposed by Tu Chuanyi (chuanyitu@pku.edu.cn) from Peking University and other scientists from Canada and European countries. The aim of this mission is devoted to the understanding of the 3-dimensional structure of the Sun's corona, their evolution in the interplanetary medium, and the dynamic coupling between CMEs and the Earth environment. The Second International Symposium on KuaFu Project was held in Jan 15-19 2007, Sanya China (http://www.spaceweather.gov.cn/ISKP-2/secannounce.htm). For details about this mission, please visit http://www.space.pku.edu.cn.

The 3rd space weather symposium by CAWSES – Space Weather Theme of China will be held in Guiyang, China during 7-13 Aug 2007. The first and second such symposia were held in Aug 2004 and Nov 2005 in Wuyishan and Macao respectively. These symposia had drawn about 160 participants each time from worldwide Chinese scientists. For details on this symposium, please contact Feng Xueshang (fengx@spacewetaher.ac.cn) or visit: http://www.spaceweather.ac.cn/spaceweather_symposium/6th.htm

CAWSES - India

Report on CAWSES Theme 2 Campaign During March-April 2006

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The highly energetic processes taking place in the Sun produce dramatic effects in the near space environment surrounding the earth and also within the earth's atmosphere. Investigations of these processes over low latitudes during space weather events have gained a significant importance due to the realization that our understanding of several science issues still remains incomplete. In this context three main scientific problems have been identified for focused studies under the Theme 2 of CAWSES-India program. These problems are:

P1: Investigation of the evolution of magnetic field structures on the sun and solar wind disturbances.
P2: Investigation of the day-to-day variability of equatorial and low latitude thermosphere-ionosphere system with an emphasis on the generation and development of Equatorial Spread F (ESF)
P3: Investigation of Solar and interplanetary origin of geomagnetic activity and related magnetospheric-thermospheric-ionospheric effects.

In order to address these problems, especially P2, a multi-institutional multi-instrument campaign was conducted during Mar-Apr 2006. Optical and radio measurements were made on various solar and terrestrial parameters simultaneously. The weather of the sun-earth system during that period was moderately disturbed with no major geo-effective solar flare occurrence. Nevertheless, many flare events were observed from observatories at Udaipur (H_α), Gauribidanur (radioheliogram) and Ooty (scintillation) during this period. Three moderate geomagnetic storms with gradual commencement were also observed. While ground-based radar (MST and HF) and GPS measurements provided temporal evolution of the ESF on three nights, daytime airglow measurements were carried out aimed at investigating the atmosphere-ionosphere coupling on a day-to-day basis. In addition, measurements obtained using the recently established receiver network for Coherent Radio Beacon Experiment (CRABEX) facilitated tomograms exhibiting the latitudinal-altitudinal distribution of ionospheric density. The main outcome of this campaign can be summarized as follows:

(a) Evidence that even small amplitude solar events could lead to systematic changes in the interplanetary-scintillations, followed by changes in terrestrial atmosphere in this solar epoch.
(b) Evidence for the E and F region coupling controlling the evolution of ESF structures, plumes in particular.
(c) Evidence of significant longitudinal differences in the occurrence of the post-evening VHF scintillations over Indian longitudes.
(d) Evidence for storm-induced lowering in the optically estimated daytime mesopause temperature over equatorial latitudes.

These results were discussed in detail in a post-campaign workshop held in Space Physics Laboratory, Trivandrum, India during Jul 4-5 2006. The workshop was convened by J. H. Sastri and P. Venkatakrishnan of Indian Institute of Astrophysics and Udaipur Solar Observatory. We are in the process of finalizing the campaign results and planning for the next phase of campaign for the year 2007. Meanwhile, for the data collected during the previous CAWSES campaigns there is a great scope for interaction such as sharing of data and joint analysis on various questions mentioned above. Through this report we invite researchers that are interested in investigating atmospheric/ionospheric processes over equatorial and low latitudes to participate in collective investigations of various science issues.

Highlights of Tidal Campaign Activities Under CAWSES-India

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The first CAWSES-India Tidal Campaign was conducted during Mar-Apr 2006 with the following objectives: a) to determine the characteristics of tides in the troposphere and lower stratosphere (0-20 km) and mesosphere and lower thermosphere (MLT) region (80-100 km), b) to explore and identify the lower atmospheric processes that drive middle atmospheric tides in the Indian continental region (vertical coupling), and c) provide information on the short-term variability of the MLT tides that are likely to have an impact on the ionospheric variability and contribute to the upper atmospheric weather (overlaps with CAWSES Theme 2 Science).

Experiments were conducted at the low latitude radar/lidar sites, namely, Trivandrum (8.5° N, 79° E), Tirunelveli (8.7° N, 77.8° E) and Gadanki (13.5° N, 79.2° E). The MF radar at Tirunelveli and the meteor radar at Trivandrum operated continuously during this period. The lidar at Gadanki was operated on moonless and clear-sky conditions. The MST radar at Gadanki was operated in 4-day windows on every alternate week during this period. As per the schedule designed for this campaign, fortnightly rocket launches, under the ongoing Middle Atmospheric Dynamics (MIDAS) program, were carried out at various local times. Rocket observations separated by 4 hours in local time over a period of three months will be combined to yield an average diurnal tidal characteristics of the dynamics. High altitude balloon launches took place four hours before the launch of the rockets.

Summary of observations:

- Significant differences in velocities were observed at heights

above 88 km between estimates of MF and meteor radar systems. The observational sites are separated by ~80 km.

- The average tidal characteristics retrieved from rocket data during the period Feb – Apr 2006 reveal tidal amplitudes reaching a peak of 35 ms^{-1} at 45 km, primarily in the zonal component with descending phase below and ascending phase above. This indicates likely constructive interference of oppositely propagating modes. The meridional phases show continuous phase descent indicating upward energy propagation along the meridian.
- Tidal amplitudes in the troposphere – lower stratosphere are small (1-2 ms^{-1}). Localized peaks in amplitudes are observed but are not in phase.

Report on CAWSES Space Weather Modeling Workshop

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CAWSES International Workshop on Space Weather Modeling (CSWM) was held at the Earth Simulator Center in Yokohama, Japan, during Nov 14 - 17, 2006. Numerical simulations and modeling are crucially important approaches for understanding the complex Sun-Earth system as well as for the prediction of space weather effects. This workshop focused on the modeling study of space weather phenomena, provided a forum to review the recent progress in modeling and to discuss the future prospects of this rapidly growing field. About a hundred scientists participated in this meeting from Canada, China, Finland, France, Germany, India, Japan, UK, and USA. Forty oral talks and forty-six posters were presented. The topics of this workshop spanned a wide spectrum from solar flares to the Earth's magnetosphere-ionosphere coupling and new simulation algorithms of solar and space plasmas. First-light results of Japanese new solar satellite "Hinode" (Solar-B) were also presented. Some of the papers presented in this workshop will be published in JGR-Space Physics-Special Section "Space Weather Modeling: Status and Prospects."

This workshop was sponsored by Grant-in-Aid of the MEXT of Japan for Creative Scientific Research "The Basic Study of Space Weather Prediction", CAWSES/SCOSTEP, Solar-Terrestrial Environment Laboratory, Nagoya University, and Research Institute for Sustainable Humanosphere (RISH) Kyoto University.

There must be no barriers to freedom of inquiry. There is no place for dogma in science. The scientist is free, and must be free to ask any question, to doubt any assertion, to seek for any evidence, to correct any errors. Our political life is also predicated on openness. We know that the only way to avoid error is to detect it and that the only way to detect it is to be free to inquire. And we know that as long as [we] are free to ask what [we] must, free to say what [we] think, free to think what [we] will, freedom can never be lost, and science can never regress.

- Oppenheimer (1904 - 1967)

Report on the Launch of the IPY Core Project #63 "Heliosphere Impact on Geospace"

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A kick-off meeting of the IPY Core Project "Heliosphere Impact on Geospace" (IPY ID#63) took place at the Finnish Meteorological Institute in Helsinki during Feb 5-9 2007 where in about 40 scientists from 14 different countries participated. The "Heliosphere Impact on Geospace" project coordinates multinational research on solar-terrestrial events which affect the composition and dynamics of the earth's magnetosphere, ionosphere, and atmosphere in the Polar regions. This is a consortium of 29 research projects from 22 countries that expressed their interest to IPY. The consortium's management responsibilities are carried out by two complementary programs: "The International Heliospheric Year" (IHY, http://ihy2007.org/) and "Interhemispheric Conjugacy Effects in the Solar Terrestrial and Aeronomy Research" (ICESTAR, http://www.scar-icestar.org/). IHY coordinates the use of current and forthcoming spacecraft missions with ground-based instruments to study the Sun's influence on the Heliosphere, including the effects at the Earth. ICESTAR, supported by the Scientific Committee on Antarctic Research (http://www.scar.org/), coordinates solar-terrestrial and aeronomy research on near-Earth space and atmospheric responses to solar input, with an emphasis on the networking of ground-based instruments and the study of interhemispheric relationships. The IPY ID#63 projects shares many scientific objectives and closely collaborates with the SCOSTEP's program "Climate And Weather of the Sun-Earth System" (http://www.bu.edu/cawses/).

The next workshop dedicated for mid-term review of the project will be arranged at the beginning of 2008. The Greenland Space Science Symposium (May 2007, http://www.gsss-2007.org/) and the Arctic Sunrise Conference in Alaska (January 2008) will be highlights of the project's outreach activities. More information about the kick-off meeting is available at the project's homepage http://www.ipy-id63.org.

Announcements

"From the Sun Towards the Earth and Beyond" – a Mobile Exhibition

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The Observatoire de Paris (France) and its partners have developed a large exhibition in the frame of IHY recognized by the United Nations. The exhibition has been produced in Switzerland by Hartmann Event in three languages (French, German, Italian) and will travel in large shopping centres and museums in Swiss, Germany, France and other countries. The exhibition consists of fifteen 2-meter height display panels, a planetarium, several 3D modules of the Sun and the planets, and a miniature model (1/4) of the satellite SOHO. It is an interactive exhibition with experiments and games for pupils above 8 years old. A genuine meteorite, more than 360,000 years old is also presented. Fourteen institutions/agencies participated in developing this exhibition. The scientific coordination was done by B. Schmieder. The French section of SCOSTEP is a partner of the exhibition. More details and renting conditions are available on the web site of Hartmann Event at http://www.hartmannevent.ch/fr/index.htm.

International CAWSES Symposium in Kyoto 23 – 27 October, 2007

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We are pleased to announce that an international symposium on CAWSES science will be held in Kyoto, Japan during 23-27 Oct 2007, which is jointly sponsored by SCOSTEP, Kyoto University and Nagoya University. This conference is being organized towards the end of the initially announced duration of the CAWSES period so that there will be an opportunity to hear about the scientific accomplishments of CAWSES and accordingly plan for the future. The symposium will cover all four of the CAWSES Themes: i.e., (1) Solar influence on climate, (2) Space weather: Science and Applications, (3) Atmospheric coupling processes, and (4) Space climatology. We plan to organize keynote and/or invited lectures that will be of interest to all participants, regardless of their primary CAWSES interest. We will also have sessions that will cover the more specialized aspects of each area. You can find more details at the symposium home page: http://www.stelab.nagoya-u.ac.jp/cawses/. The autumn period is very beautiful in Kyoto and there is a very famous Japanese festival on the day preceding the symposium (22 October). We hope that you will consider joining this symposium and present your results on CAWSES related subjects. Please note that the deadline for abstract submission is 31 May 2007. Conveners of the CAWSES symposium are T. Tsuda, R. Fujii, K. Shibata and M. A. Geller.

IHY-Africa Space Weather Science and Education Workshop Nov 11 - 16, 2007, Addis Ababa, Ethiopia

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The IHY-Africa Space Weather Science and Education Workshop will be held in Addis Ababa, Ethiopia during Nov 12-16 2007. The meeting will follow the 2nd Africa SCINDA Workshop on Sunday 11th November. The Workshop is under the auspices of IHY, in cooperation and collaboration with several other international and African national programs including CAWSES, eGY, AMMA, and AFREF. The workshop is sponsored by several US and International Agencies. The purpose of the workshop is to facilitate scientific interaction and promote space science and education in Africa. The space science community is currently exploring ways to increase the observational infrastructure in the African sector, to encourage scientists in sub-Saharan Africa to become involved in the science objectives, and to host instrumentation at their institutions. The new observational infrastructure will facilitate the study of space weather, spark interest in space science education and research, and encourage the next generation to become interested in the space sciences. The workshop will provide an ideal opportunity to develop strong interactions with scientists in Africa. Workshop Web Site: http://sirius-c.ncat.edu/IHY-Africa/

CAWSES News
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CAWSES International Coordination office at B.U. is supported by US NSF