The CEDAR Post

August 2000 Volume 40

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FY2001 FUNDING OPPORTUNITY

MAGNETOSPHERE-IONOSPHERE COUPLING INITIATIVE

PROPOSAL DEADLINE: OCTOBER 15

The Magnetosphere-Ionosphere Coupling Initiative is a joint effort by the NSF CEDAR and GEM programs to foster research in the study of processes linking the magnetosphere and ionosphere systems. The objective of this initiative is to support research that does not obviously fall within the domains typically supported by the CEDAR and GEM Programs. Following are examples of areas of research toward which this competition is aimed:

• The temporal and spatial variability of ionospheric outflow and its effect on the electrodynamics, composition, and wave-particle interactions in the magnetosphere

• The global electric field distribution in the ionosphere: how it responds spatially and temporally to magnetospheric forcing; how it affects plasma processes in the magnetically conjugate magnetospheric regions; its role in the development of ionospheric plasma structuring at all latitudes

• The global distribution of aurorally-produced conductivity and how its temporal and spatial variability affect the electrodynamic properties of the ionosphere-magnetosphere system, including horizontal and perpendicular currents and Joule heating

• Auroral plasma energization, collisionless energy dissipation, field-aligned currents, and other processes operating along magnetic field lines that influence the coupling between the magnetosphere and ionosphere

• The way in which magnetosphere-ionosphere coupling gives rise to multi-scale processes manifested in phenomena such as discrete aurora, filamentary and layered auroral structures, polar cap arcs and patches, etc.

• The connection between ionospheric and neutral dynamics and the electrodynamic properties of the magnetosphere

• Coupling of conjugate ionospheres via transport of conjugate photoelectrons along field-lines threading magnetospheric plasmas

The above list is not meant to be all-inclusive. Proposers should note that many areas of M-I coupling research are supported through the Aeronomy and Magnetospheric Physics base programs. This initiative

- *Continued on next page*

is aimed toward research that also overlaps with current areas of emphasis within the GEM and CEDAR programs. Proposers should consult the web pages for the two programs for more detailed information about these areas of emphasis: http://www-ssc.igpp.ucla.edu:80/gem/Welcome.html and http://www.nsf.gov/geo/egch/gc_solar.html#cedar

Approximately $500K will be available in FY2001 for this initiative with equal contributions from the GEM and CEDAR programs. Award durations will be no more than three years. Proposals should be submitted to the GEM proposal competition with a proposal due date of October 15, 2000. An additional amount of about $250K will be available for other GEM proposals. Proposers to this initiative should distinguish their proposals from other GEM proposals by preceding the title of the proposal with the words "M-I Coupling:".

–The GEM and CEDAR Steering Committees

THE CEDAR AND GEM MAGNETOSPHERE-IONOSPHERE COUPLING CAMPAIGNS

During this past June, both the CEDAR and GEM communities initiated a new collaborative research activity devoted to improving our understanding and specification of the role of the ionosphere and ionospheric plasma in the coupled magnetosphere-ionosphere system.

Important consequences of this research apply not only to the electrodynamic coupling of the current systems that flow between the magnetosphere and ionosphere but also to the mechanical coupling between the thermosphere and ionosphere and its impact on global wind systems.

At CEDAR, there was a two-hour workshop in which more than 60 scientists and students participated. Eleven speakers gave brief presentations on issues they believed to be of importance. One issue that arose repeatedly was the detailed current-voltage-conductance relationships that exist in the high-latitude ionosphere. It was recognized that our detailed understanding of these relationships, at scale sizes down to that of an auroral arc, is not very good. This issue is of importance for understanding closure of magnetospheric current systems and also for understanding a closely related quantity, Joule heating. A. Richmond discussed how AMIE modeling might help in these studies but noted that AMIE estimates vary with the data inputs; the AMIE procedure could be used to examine the consistency between various inputs. Several other speakers, R. Smith, J. Thayer, and G. Crowley, discussed related issues on the importance of understanding Joule heating and its impact on the global ionosphere and atmosphere. J. Foster and B. Fejer discussed the impact of high-latitude electric fields penetrating to lower latitudes and severely affecting the mid-latitude and even low-latitude ionosphere. In particular, Foster noted evidence of significant outflow of ionospheric plasma into the magnetosphere. There were also discussions on the impact

FROM THE CEDAR SCIENCE STEERING COMMITTEE

The 2000 CEDAR meeting was held in Boulder from June 25 to 30. This issue of the Post provides a summary of the meeting and the afternoon workshops. The meeting is organized by the CEDAR Science Steering Committee (CSSC), which is composed of members from the US aeronomy community along with two international representatives and one student representative. These members serve for three years, two years, and one year, respectively. At the June meeting, several members completed their terms of service; these were Monica Angelats i Coll (U. Colorado, Boulder), Maura Hagan (NCAR), Michael Hickey (Clemson U.), Chiao-Yao She (Colorado State U.), Jean-Pierre St.-Maurice (U. Western Ontario), and Mike Sulzer (NAIC/Areicbo Observatory). Many thanks to these members for their time, energy, and efforts and especially for their very substantial assistance with the organization of this year's meeting.

The CSSC welcomes new members Leroy Cogger (U. Calgary), Sixto Gonzalez (NAIC/ Arecibo Observatory), Delores Knipp (US Air Force Academy, Erhan Kudeki (U. Illinois), Colorado Springs), Art Richmond (NCAR), and student representative Rebecca Bishop (U. Texas at Dallas). Congratulations to Chair-elect Roger Smith of the Geophysical Institute, University of Alaska; his two-year term as chair begins after next year's CEDAR meeting, on June 24.

The 2001 CEDAR meeting will be a special event – it is being held jointly with the 10th quadrennial Solar-Terrestrial Physics(STP) symposium. STP is sponsored by SCOSTEP, the Scientific COmmittee on Solar-Terrestrial Physics. The meeting venue is the Raintree Plaza Hotel Conference Center in Longmont, Colorado, about 12 miles NW of Boulder. Current estimates are that about 600 participants (300 each from CEDAR and SCOSTEP) will attend. There will be a common registration fee of $200. This is larger than the typical registration fee for CEDAR but it is necessitated by the greater expenses incurred for an international meeting at a hotel conference center. More details will be given in the next CEDAR Post and can be found at the meeting website http://cedarweb.hao.ucar.edu/wkshp/.

The CSSC will meet at NSF in the fall to review CEDAR issues, to continue planning the summer workshop, and to discuss a variety of issues, including the CEDAR data base and progress on the Phase III initiatives. If you have any input, ideas, or suggestions on any CEDAR-related matter, please contact any one of the CSSC members; their contact information is listed on the next-to-last page of this newsletter.

–C. G. Fesen, UTD

FY2000 CEDAR-TIMED COMPETITION

NSF received 39 proposals to the CEDAR/TIMED competition. Fifteen awards were made, totaling approximately $1.5M; they are listed below.

PI	Institution	Title
Avery	U. of Colorado	Dynamics of the Antarctic MLT region
Bristow	U. of Alaska	SuperDARN contributions to TIMED/CEDAR
Conde	U. of Alaska	Thermospheric vertical wind observations
Crowley	SWRI	Global Joule heating and atmospheric response
Greenwald	JHU/APL	SuperDARN contributions to TIMED/CEDAR
Hagan	NCAR	TIMED/CEDAR global scale ITM interactions
Hecht	Aerospace	Lower thermospheric composition studies
Lieberman	Colorado Res. Assoc.	Tidal, planetary, and mean wind variability
Palo	U. of Colorado	Coordinated analysis of the MLT
Salah	MIT Haystack	Geomagnetic storm effects on the lower thermosphere
Sandor	Space Science Inst.	Chemical-dynamical interaction in the mesosphere
She	Colorado State	Two-beam sodium lidar for CEDAR-TIMED
Sivjee	Embry-Riddle U.	Energetics and dynamics of the MLT region
Swenson	U. of Illinois	Gravity wave studies at Albuquerque, NM
Taylor	Utah State U.	Collaborative all-sky image measurements

– Bob Robinson, NSF

AERONOMY AND SPACE WEATHER

SPACE WEATHER EFFECTS AND METRICS

The concept of "space weather" has created a new way of envisioning processes taking place in the near-Earth space environment and how they change in response to varying solar radiation and solar plasma ejections. Over the years, many in the space science community have developed a somewhat limited notion of just what space weather encompasses. It is quite common to find meetings or programs with the label space weather, yet which focus exclusively on solar coronal mass ejections and/or magnetospheric storms. But that limited interpretation excludes many if not most space weather processes. Bob Schunk from Utah State University has estimated that 70% of space weather occurs in the ionosphere. Regrettably neither the agencies funding space science nor the scientific meetings reflect that percentage. Table 1 lists a variety of space weather phenomena of interest to the operational community. All of these effects, except for high energy particle bombardment of spacecraft, involve the ionosphere or thermosphere. Even biological effects on humans, which are normally associated with energetic particles, must also include the collisional hazards of space debris whose orbits are largely controlled by atmospheric drag in the thermosphere.

The "Study of Metrics for the National Space Weather Program" lists top priority metrics. Most of these either explicitly specify the ionosphere and thermosphere or identify solar radiation and wind parameters needed for ionosphere/thermosphere model input. Likewise, 2/3 of the metrics requirements for the Space Environment Sensor Suite of the National Polar-orbiting Operational Environmental Satellite System (NPOESS) are aeronomical. By any measure, space weather effects and their metrics support Schunk's contention that 70% are ionospheric or thermospheric in nature.

HOW IS AERONOMY DOING?

By far, most of the NASA missions in the Sun Earth Connections theme have emphasized and continue to emphasize solar and magnetospheric physics. Since 1981, only TIMED (to be launched in 2001), which largely ignores the ionosphere, and GEC (to be launched in 2008) resemble aeronomy missions. The NSF Space Weather Initiative, I have been told, funds proposals approximately equally among the solar, magnetosphere, and aeronomy disciplines. While aeronomy is doing somewhat better at NSF, that proportion is still inverse to what might be expected from the Schunk percentage. On the other hand, DoD has been much more supportive of aeronomical monitoring. The Space Test Program has flown research satellites carrying aeronomy instruments and the next generation of DMSP satellites will carry UV remote sensors of the thermosphere/ionosphere. And the joint DoD/NOAA NPOESS program is planning to fly similar sensors.

In the scientific arena, I searched AGU meeting abstracts for the past five years, using the key words "space weather". I found some 222, of which only 21% were aeronomical in content. At the recent Clearwater Chapman Conference on Space Weather in March, 2000, there were eight ionospheric and one thermospheric invited papers out of 61 total. The

TABLE 1: SPACE WEATHER EFFECTS

- Ionospheric Influence on Electromagnetic Propagation (Radar, Transmission, Communications, Navigation, ...)
- Atmospheric Drag on Satellites and Debris
- Surface Corrosion by Atomic Oxygen (& Solar UV)
- Energetic Particle Effects on Spacecraft
- Spacecraft Charging
- Induced Currents in Ground Power Systems and Pipelines
- Biological (Humans in Space nd Airborne)
  - Energetic particles
  - Space debris collisional hazards

scientific community seems to exhibit even less support for aeronomy in space weather than the agencies.

WHAT ARE THE PROBLEMS?

As indicated above, many perceive that space weather only happens in the magnetosphere and is caused by coronal mass ejections. There is a lack of community awareness that space weather research currently focuses on only 30% of actual space weather processes. Anecdotal information leads me to conclude that many space scientists believe that the burning aeronomy problems were solved more than 20 years ago. That perception is certainly incorrect as evidenced by the many disagreements between observations and models. The lack of space missions of the caliber of those solar and magnetosphere missions which have flown in the interim and made so many wonderful discoveries is central to this misperception. The UARS mission changed our view of the stratosphere and mesosphere. An aeronomy mission or two would have done the same for the thermosphere and ionosphere.

WHAT ARE THE SOLUTIONS?

Clearly, the participation of more aeronomers in space weather programs and activities is needed. We must raise the consciousness not only within our own discipline, but also within the broader space science community and in the agencies. The next NASA space weather program is "Living with a Star". While much of this program is again focused on the Sun and magnetosphere, we must face the challenge to define a 21st century Ionosphere Mapper Mission which will put aeronomy on the space weather map. The Fall AGU meeting will have a special session entitled "The Aeronomical Impact of Space Weather". This is the first of what I hope to be many events designed to draw attention to the role of aeronomy in space weather. We cannot afford to ignore these opportunities.

– R. R. Meier, AGU Aeronomy Secretary (2000-2002),
E. O. Hulburt Center for Space Research,
Naval Research Laboratory

PUBLIC INTEREST IN SPACE WEATHER AND AURORA BRINGS VISITORS TO ALASKA

The solar maximum has spurred interest of the popular media in Space Weather and aurora. At the Geophysical Institute at the University of Alaska we have experienced more inquiries from local and national papers, radio stations, and TV reporters during this last winter than usual. Press releases from NASA have no doubt contributed to this heightened public awareness. As reported in the last CEDAR Post, the Sondrestrom facility had been visited by journalists from Scientific American. An article in the July issue of Discover Magazine features the Poker Flat Research Range (PFRR) in Alaska.

Discover Magazine sent journalist Karen Wright and photographer Max Aguilera-Hellweg to Alaska for five days late February to early March to experience the aurora first hand. Their timing was unfortunate: they missed two successful rocket launches by just a few days. They had, however, good aurora and clear skies. Both journalists came out to the observatory and spent long nights there waiting for aurora. Karen Wright had the opportunity to interview not only scientists from the Geophysical Institute, but also met Bob Eather, who visited PFRR for a two week moon-down period with his IMAX camera to obtain additional material for the "SOLARMAX" IMAX movie.

Photos of the Observatory and of aurora are published along with a several-page-long article in the magazine. A global view of the aurora from the POLAR PIXIE X-ray imager is shown on the magazine cover.

The aurora is getting the attention not only of journalists but also of artists. A well known choreographer, Maida Withers, from George Washington University (Washington, DC) visited PFRR and the Geophysical Institute last winter. She is working on a multimedia (dance, sound, and visual arts) presentation which is inspired by the northern lights: "Aurora/2001: Dance of the Aurora-Fire in the Sky." This performance will include animations and pictures from various satellites and ground based instruments. The premiere is planned for February 2001 at George Washington University's Lisner Auditorium (see http://www.gwu.edu/~media/press releases/05-19-00-Aurora2001.html).

– Dirk Lummerzheim,
Geophysical Institute, U. of Alaska

PSMOS SCIENCE HIGHLIGHT: GLOBAL SCALE TIDAL VARIABILITY

The Planetary Scale Mesopause Observing System (PSMOS) is one of the international solar-terrestrial physics (STP) programs that the Scientific Committee On Solar-TErrestrial Physics (SCOSTEP) currently organizes and conducts in cooperation with other International Council For Science (ICSU) bodies. The PSMOS web site (http://www.hao.ucar.edu/psmos/home.html) contains a detailed description of PSMOS activities. Progress in six key areas of PSMOS research was reported at the recent PSMOS 2000 Workshop and will be published in a special issue sometime next year. Herein, we highlight a component of the PSMOS 2000 Global Scale Tidal Variability (GSTV) progress report.

The PSMOS GSTV project (http://www.aber.ac.uk/~dphwww/research/psmos.html) conducted an observational campaign with a suite of meteor and medium frequency radars during June through August 1999. Radar wind data were provided by Ronald Clark, Antonina Fahrutdinova, Grahame Fraser, Wayne Hocking, Kiyoshi Igarashi, Christoph Jacobi, Owen Jones, Boris Kashcheyev, Sandile Malinga, Alan Manson, Nick Mitchell, Heinz Muller, Dora Pancheva, Yuri Portnyagin, L.M.G. Poole, Takuji Nakamura, Terry Robinson, Werner Singer, and Robert Vincent. GSTV project co-leaders Dora Pancheva and Nick Mitchell coordinated the analysis and interpretation of the observations. One GSTV campaign objective involved the harmonic decomposition of the wind data to assess the monthly variability of tides in the mesopause region. The resultant tidal climatologies were compared with the newly updated global-scale wave model (GSWM-00) predictions provided by Maura Hagan. The GSWM-00 monthly climatologies resulted from a simple extension to GSWM-98 [Hagan et al., JGR, 1999], since most of the model inputs vary with month inherently. Only the seasonally variable GSWM-98 tropospheric tidal forcing scheme and the parameterization that accounts for the gravity wave drag on the diurnal tide required modification. These inputs were linearly interpolated for the GSWM-00 calculations.

The monthly averaged zonal and meridional diurnal amplitude diagnostics are plotted in the accompanying figure as a function of latitude. The data points represent the observed tidal wind signatures near ~92 km. Some are meteor radar diagnostics of height-integrated meteor trail measurements, so GSWM-00 migrating tidal predictions near both 91 and 95 km are illustrated to provide perspective on the expected amplitude variations within this altitude regime. Migrating diurnal wind amplitudes peak at low latitudes and are largest (smallest) in August (June). There is generally good agreement between the observations and model predictions, although there are large data gaps near ±20° to 30° where both the amplitudes and the variations are expected to peak (see the figure). Similar comparisons between the semidiurnal results reveal significant discrepancies (not illustrated) at summer high latitudes. GSWM-00 predicts a weak semidiurnal tide (~5-10 m/s) in this regime and underestimates the observations by a factor of two. Differences in the winter hemisphere are more in keeping with the diurnal amplitude results illustrated in the figure. There is generally good agreement between the modeled and measured phases of both components (not illustrated). The interpretation of these results remains the subject of on-going investigation. The observations may contain non-migrating tidal signatures which GSWM-00 does not yet account for. Lower and middle atmospheric zonal winds profoundly affect tidal signatures aloft, so model/measurement discrepancies may also be attributable to differences between the GSWM-00 background wind climatologies and the monthly averaged winds that prevailed during the campaign period.

This PSMOS view of ground-based tidal determinations provides an invaluable perspective of these fundamentally global phenomena. Such perspectives complement CEDAR Phase III initiatives, since tides are key to our understanding of upper atmospheric Coupling with Lower Altitudes. These and other coordinated analyses of simultaneous observations made with a variety of instruments at distributed locations are critical to the pursuit of the unresolved challenges of mesopause region research that will continue to be addressed by PSMOS, CEDAR, and TIMED.

– Maura Hagan, NCAR

Summary of the 2000 CEDAR Workshop

NIST/NOAA, BOULDER • JUNE 25-30, 2000

The 2000 CEDAR Workshop was held between Sunday June 25 and Friday June 30 at the NIST/NOAA campus in Boulder, Colorado. A total of 305 persons from 72 institutions, 17 outside the United States and Puerto Rico, attended the CEDAR Workshop. This year, 109 students came from 28 universities and 6 research labs, including nine students from Canada, Taiwan, Japan, and the United Kingdom. One CEDAR Post-Doc also came from Jicamarca Observatory in Peru. The total number of students dropped by 2, while non-student participation increased by 2, so the total number of participants was the same as in 1999. There were 47 universities represented at the Workshop, 20 research laboratories, and 5 small businesses.

The first scheduled event at each year's CEDAR meeting is the Student Workshop on Sunday. This year's student workshop was organized by the CSSC student representative Monica Angelats i Coll of the University of Colorado and covered the topic "Comparative Planetary Atmospheres". The workshop is further described in a separate article on page 10. Students and non-students alike benefited from Bishop's Acronym Guide (B.A.G.), a small booklet containing hundreds of space-science-related acronyms compiled by graduate student Rebecca Bishop of the University of Texas at Dallas. The booklet was distributed to everyone at the workshop and is available electronically at http://www.utdallas.edu/~rbishop/bag.html. It is also accessible through the CEDAR homepage, Community Information, at http://cedarweb.hao.ucar.edu/common/cedarcom.html

The CEDAR Prize lecture was given by Joshua Semeter of SRI International on "The information content of the aurora". The first of four tutorial speakers, Stephen Bougher of the University of Arizona, talked on "Comparative terrestrial planet thermospheres: Venus, Earth and Mars". His talk was followed by a panel discussion on planetary atmospheres chaired by Michael Mendillo. A workshop on "Aurora and airglow in the solar system" completed the emphasis on extraterrestrial atmospheres at the meeting. The other tutorial speakers were Franz-Josef Luebken of the University of Rostock in Germany, who spoke on "The thermal structure of the upper mesosphere and its relationship to layered phenomena"; John Foster and Joseph Salah of MIT/Haystack Observatory, speaking on "Ionospheric effects and storm studies: A tribute to Michael Buonsanto"; and Howard Singer of SEC/NOAA, who lectured on "The magnetosphere and space weather". Hard copies of the transparencies for the tutorials are available, as are video tapes of these talks. Please contact Barbara Emery (emery@ucar.edu, HAO/NCAR, PO Box 3000, Boulder CO 80307) if interested in obtaining copies.

The morning sessions included eight 20-minute science highlight talks by members of the community and 13 briefings on various programs. Participants also heard reports from two CEDAR Post-Docs, as well as a tribute to Gerald Romick, the first chair of the CEDAR Science Steering Committee, who retired in May from the Applied Physics Laboratory, given by Andrew Christensen. The afternoon sessions were devoted to 25 workshops; these are summarized in a separate section of this newsletter.

A total of 87 posters were shown in two large basement rooms of the NOAA David Skaggs Research Laboratory. Half the posters were on display during the day Tuesday and also during the poster session and reception in the cafeteria that evening.

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CEDAR WORKSHOP SUMMARY

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The process repeated for the second half of the posters which were shown on Wednesday. As in past years, the poster session included a student competition; see the next article for a description of this year's winners.

The extra-curricular activities this year included tours of the new Space Environment Forecast Center in the NOAA Skaggs building; these tours occurred during the Wednesday evening poster/reception. On Thursday, June 29, Dennis Ebbets of Ball Aerospace gave a slide show on the Hubble Space Telescope to mark the 10 years it has been in space. Later that evening, 60 participants and family members watched the show "Searching for Distant Worlds" at the Fiske Planetarium on campus.

– Barbara Emery, HAO/NCAR

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2000 CEDAR STUDENT POSTER CITATIONS

The 2000 CEDAR Workshop included poster sessions with a total of 87 posters; forty were by students, including four by undergraduates. All but six students entered the student poster competition.

A panel of fourteen judges selected four Outstanding Posters; three posters received an Honorable Mention. All seven received certificates; the Outstanding Poster presenters also received vouchers for publications from the AGU Space and Planetary Sciences collection.

The Outstanding Poster citations were awarded to the following students:

Rebecca Bishop, for the poster *Intermediate Layers and Associated Vertical Ion Drifts,* by R.L. Bishop and G.D. Earle. Rebecca is from the University of Texas at Dallas and expects a Ph. D. in May 2001. Her research interests are midlatitude ionospheric irregularities, particularly intermediate and sporadic E layers.

Lars Dyrud, for the poster *Simulations and analysis of meteor trail plasma dynamics and diffusion in the ionosphere,* by L.P. Dyrud, M.M. Oppenheim, G. Vetoulis, and A.F. vom Endt. Lars attends Boston U. and expects a Ph.D. in 2003. His research interests include the equatorial electrojet, auroral ionosphere plasma irregularities, and meteor trails in the ionosphere.

Katia Matcheva for the poster *Gravity Wave Signatures in the Ionosphere of Jupiter,* by K.I. Matcheva, D.F. Strobel, and F.M. Flasar. Katia attends the Johns Hopkins University and expects a Ph. D. in August 2000. Research interests center on the physics and chemistry of planetary atmospheres and geophysical fluid dynamics.

Tian-You Yu for the poster *Observations of PMSE Using Coherent Radar Imaging: Direct Evidence of Wave Steepening,* by T.-Y. Yu, R.D. Palmer, and P.B. Chilson. Tian-You attends the University of Nebraska-Lincoln and expects a Ph. D. in September, 2000. Research Interests include radar imaging techniques and polar summer mesospheric echoes.

Honorable Mentions were awarded to:

Kim Cierpik, for the poster *Migrating and Nonmigrating Semidiurnal Tide Components From Combined Space-based and Ground-based Measurement,* by K.M. Cierpik, J.M. Forbes, S.E. Palo, A. Fahrutdinova, C. Jacobi, A. Manson, S. Miyahara, N.J. Mitchell, and Y. Portnyagin. Kim is from the U. of Colorado.

Gilbert Lichstein for the poster *Simulation of 3-day Kelvin wave influence on Greenline, O2 Atmospheric, and OH Meinel band emissions in the MLT region,* by G.S. Lichstein, J.M. Forbes, and M. Angelats i Coll. Gilbert attends the U. of Colorado.

Daniel Self for the poster *The Photolysis of Sodium Compounds in the Upper Atmosphere,* by D.E. Self and J.M.C. Plane. Daniel is from the University of East Anglia in the UK.

– Maura Hagan, NCAR, Roger Smith, Geophysical Institute, U. of Alaska, and Jean-Pierre St-Maurice, U. of Western Ontario

Workshop Reports

STUDENT WORKSHOP REPORT COMPARATIVE PLANETARY ATMOSPHERES

Convener: M. Angelats i Coll

The CEDAR 2000 meeting kicked off this year with a Student Workshop focusing on the topic of Comparative Planetary Atmospheres. The session was held on June 25 and was attended by 75 students plus some other non-student CEDAR participants. The workshop included a series of presentations followed by the now traditional evening social.

The reasons for the topic selection were two-fold: first, comparative planetary research is an interesting tool to apply our knowledge of certain areas of our atmosphere to the understanding of other planetary atmospheres and vice versa; second, the topic allowed for a variety of scientific subjects to be covered, therefore encompassing most areas of interest to the students.

The session started with some words from John Meriwether who gave the audience some insight on the grant proposal reviewing process at NSF. This was reportedly very helpful to the students since most have not been exposed to the NSF reviewing process yet. He also talked about budget issues in regards to comparative planetary atmospheres research.

The next part of the workshop consisted of half-hour tutorial-like presentations on a topic given by graduate students or recent graduates. Chris Pankratz from Johns Hopkins University introduced the subject by describing the solar influences on planetary atmospheres. Marlene Colerico and Carlos Martinis, both from Boston University, gave very useful information about neutral atmospheres and ionospheres, respectively, of the planets. After a brief break, we heard about planetary magnetospheres from David Brain from the University of Colorado. The last three talks covered more specific research areas such as auroral processes in the solar system by Marina Galand from Boston University; gravity waves on other planets by Katia Matcheva from Johns Hopkins University; and issues on modeling planetary thermospheres by Ingo Mueller-Wodarg from University College-London.

The evening social was held at a different venue this year. Eben G. Fine Park was chosen to give students and other participants a new area to discover and explore, since the park is located by the Boulder creek and close to nice hiking trails and downtown. The weather, however, did not cooperate and by the time the talks were over it was pouring! Even so, the social was, again, a great opportunity for students to get acquainted with each other, relax, play frisbee, and go for walks once the weather relented. The evaluation of the workshop and evening social were very positive, and were indeed a great learning experience for the convener.

AERONOMY OF THE METEORIC METALS

Conveners: Tim Kane and Rich Collins
(tjk7@psu.edu; rlc@gi.alaska.edu)

This brief workshop offered an open forum from which to discuss the aeronomy of the meteoric metals present in Earth's middle and upper atmosphere (following naturally from the previous day's Meteor workshop). The atomic forms of the meteoric metals, among them sodium (Na), iron (Fe), potassium (K), calcium (Ca), etc., have been observed from the ground using resonance Lidar systems for many years. Remarkably, there is still much to be learned about the behavior of these metals. John Plane, from the University of East Anglia, kicked off the workshop with an overview of our current understanding of the chemical and dynamical evolution of these metals. The floor then opened to discuss where years of metal density measurements have gotten us and, more importantly, where the future lies in continuing metal density measurements.

Selected Discussion Points

• The metals are tracers of certain atmospheric dynamics/chemistry

processes if properly interpreted (Note: extended discussion of this topic appeared in several other workshops).

• Na can potentially serve as a nucleus for NLC ice crystal formation (J. Plane, 2000).

• The metals may serve as catalysts for water formation in the middle mesosphere (Siskind and Summers, GRL, 2000).

• Does meteoric "dust" significantly impact the mesopause region's chemistry?

• What impact do the precipitating metals have on stratospheric aerosols, etc? (as brought up by surprise workshop participants from NOAA's Aeronomy Lab).

Action Items (in no particular order)

• Obtain simultaneous measurements of Fe and Na, as well as Ca/Ca+.

• Resolve discrepancies between models and observations under daylight conditions.

• Potential sub-orbital missions were discussed, including chemical releases (e.g., Na, H_20, etc.).

• Address origin of metallic ions in the F-region.

• Etc.

Note that the above topics are not inclusive; the workshop evolved into the hallway and beyond. The additional topics discussed in those settings will inevitably foster further experimentation/modeling and future workshops!

AIRGLOW AND AURORA IN THE SOLAR SYSTEM

Conveners: Marina Galand and Michael Mendillo
(mgaland@bu.edu; mendillo@bu.edu)

The planets, moons, and comets of the solar system offer a diverse set of emissions from atmospheres that are both similar to and remarkably different from the terrestrial system studied by the CEDAR community. To begin this first-of-its-kind workshop at CEDAR, Stan Solomon (University of Colorado) provided an overview of the many mechanisms that can excite airglow emissions and of the physical parameters (e.g., composition and temperature) that can be determined from optical signatures. Specific examples dealt with the 6300 A and 5577 A emissions that occur on Earth, Venus, and Mars. Tom Slanger (SRI International) then presented sample observational results made possible by high spectral resolution methods using the new Keck telescope to observe new terrestrial bands and 5577 A emission seen for the first time from Venus. Dirk Lummerzheim (Geophysical Institute) provided a transition to the study of aurora by showing how energetic electrons provoke strong ultraviolet emissions in the Earth's atmosphere and those of all the giant planets, of the non-magnetized Venus, and of the Jovian moon Ganymede. The companion issue of optical signatures produced by protons and heavy ions precipitating into planetary atmospheres was then treated both observationally and via modeling by Marina Galand (Boston University). Harold Frey (Berkeley) then took the unifying theme of optical signals from a planet and generalized it to the topic of using such signatures to identify possible extra-terrestrial sites that could sustain life. Audience participation was active on this final topic and in the subsequent discussion of how planetary and terrestrial studies, when done in comparative mode, bring insights and context to atmospheric science investigations regardless of their location in the solar system.

Encouraged by the number of participants and enthusiasm for more involvement by CEDAR colleagues, the conveners will set up a new website dealing with "Comparative Aeronomy in the Solar System". We will use the ~80 names and e-mail addresses provided by the workshop sign-up sheet for initial distribution of information. If you want to be added to the list and/or have suggestions and comments to make, please send information to mgaland@bu.edu.

ANALYZING WAVES IN LIDAR DATA

Conveners: Richard Collins and Patricia Franke

(rlc@gi.alaska.edu; pfranke@uiuc.edu)

The workshop brought together members of the community interested in participating in discussions of issues concerning the processing of lidar data in our quest to identify gravity waves and their effect on the background temperature and wind conditions. Several presentations were given during and after which open discussion occurred. The session was introduced by Rich Collins (University of Alaska) who set in front of the audience some issues to think about during the presentations. The issues addressed what the spectrum of waves calculated from the data really contains: propagating linear gravity waves, as is usually assumed, or something more complex. All the presentations pointed to the second answer.

Patricia Franke (University of Illinois) discussed nonlinear wave features in the Starfire Na density, temperature, and wind measurements. Alan Liu and Gary Swenson (University of Illinois) presented instability structures and wave-driven flux measurements from the Starfire lidar and airglow observations. Both of these presentations focused on the role of the large-scale waves and tides in modulating the behavior of smaller-scale waves and generation of instabilities. Biff Williams (Colorado State University) discussed the estimation of tides in lidar data and the need to distinguish between large-amplitude wave events and true tidal behavior in night-to-night observations. This presentation also discussed the challenges in interpreting the mesopause inversion layers. Finally, Maura Hagan (NCAR) discussed the role of tides and waves in analyzing mesospheric inversion layers. Of concern in the analysis of these mesospheric inversion layers is the need to separate events that represent the superposition of several waves and tides from true nonlinear wave/mean-flow interactions. In general each presentation addressed the difficulties in looking at different scales of phenomena in the data and identifying wave/mean-flow interactions. Discussion from the participants raised a variety of questions;

- How do we use short-duration observations in analyzing events that involve tidal or mean-flow interactions?

- Does the fitting of monochromatic waves to the dominant features in the data bias our understanding of the data? (When is a wiggle a wave?)

- What is the role of single station lidar measurements in the face of the upcoming TIMED mission? How can measurements from different sites with different capabilities be intercompared?

Action Items

The organizers intend to start an on-line discussion group this fall to continue this community discussion. An announcement will be made to the CEDAR mailing list when it is established.

ARECIBO OBSERVATORY: AN IMPROVED FACILITY FOR RESEARCH

Conveners: Don Farley and Mike Sulzer

(donf@ee.cornell.edu; sulzer@naic.edu)

This workshop took place on Thursday, from 1-3 pm, with about 35-40 people attending. Mike Sulzer first reviewed the radar situation. Moving the HF heater to the Observatory itself is under study, leading we hope to a full proposal to NSF. The 430 MHz Gregorian feed is nearly finished, so we will soon have a capability for wide band plasma line studies and simultaneous probing with two beams (the line feed and the Gregorian). Dual beam measurements will benefit most of the World Day programs and especially the drift velocity measurements that provide winds and electric fields. Data taking software is still needed for the dual beam. There was considerable discussion with the audience, which included representatives from most or all of the ISRs, about numerous software topics. All the radars have

similar software problems and goals, and it is clear that they can learn from each other. The opinion of several was that a small workshop of a day or two, perhaps at Arecibo or Millstone Hill, devoted entirely to software issues would be valuable.

Next Craig Tepley reviewed the optical program at Arecibo and described recent major lidar upgrades. Optical observations are taken on 10-11 nights per month, typically. The major push at the moment at Arecibo is to perfect potassium line temperature measurements, a challenging measurement, but one that can provide a great deal of useful data. There was discussion of the desirability of doing all-sky imaging on a more regular basis, rather than just during campaigns, with instruments provided by visitors. An imager costs $40-45K, but an extended loan might also be possible.

Sixto Gonzales summarized a successful 2-day topside workshop held recently at the Observatory, and finally Nestor Aponte described the new "regularization" data analysis procedure now in place for reducing line-of-sight drift velocities to winds and electric fields. Perhaps surprisingly, simulations show that the new procedure is far better than the analysis schemes used in the past. Further details on both of these topics is available at the Arecibo web site (http://www.naic.edu).

CEDAR STORM STUDY

Convener: Bob Sitar
(rsitar@haystack.mit.edu)

The workshop began at 1:30 PM in Skaggs GC-402 with introductions of participants in the room at that time. Attendance was high, estimated at 70+ at times, with 52 persons placing their names on the sign-in sheet. The workshop began with discussion about the Millstone Storms Workshop, the dates for which have yet to be determined. Most of the discussion was focused on how best to include the GEM and Shine communities in the workshop. Though no specific plans were made, the suggestions of the community provided a good direction for the Millstone workshop. The planning discussion was followed by a number of presentations describing ongoing Storm Study projects and their results. A more detailed summary of the planning discussion and information about the presentations can be obtained from the CEDAR Storm Study website (http://www.haystack.edu/css/) or by contacting Bob Sitar (rsitar@haystack.mit.edu).

CEDAR-TIMED OBSERVATIONS OF STORM EFFECTS ON THE MESOSPHERE AND LOWER THERMOSPHERE

Conveners: Joseph Salah and Larisa Goncharenko
(jes@haystack.mit.edu; lpg@haystack.mit.edu)

This planning workshop was aimed at informing the community about a coordinated project between the CEDAR ground-based observations and the TIMED satellite to study the effects of geomagnetic storms on the mesosphere and lower thermosphere. The TIMED satellite is expected to be launched in early March 2001, and a special alert system has been developed to allow incoherent scatter radars and other instruments to gather data in response to storms. The emphasis is on the region between 100 and 150 km, and will concentrate on the response of the plasma and neutral atmosphere at these altitudes. In addition to the observations, a strong modeling component is included in the project.

An overview of the project was first presented by Joe Salah, stating the science objectives and questions to be addressed, introducing the participating groups and instruments, and outlining the data acquisition and data analysis strategies. Members of the community were invited to participate. The group discussed the

schedule for the observations in 2001. Two 4-day campaigns in June and September 2001, within a 10-day floating period where the radars will be on stand-by for a magnetic storm alert, have been planned.

Sam Yee (JHU/APL) described the TIMED data system and the methods being developed to plan TIMED experiments and to access the data. Larisa Goncharenko (MIT/Haystack Observatory) described the approach for the ISR data processing and the schedule for making the basic and derived parameters available to the community.

Science presentations were then made illustrating measurements and model results available on storm effects in the lower thermosphere. Shenpan Zhang (York University) showed some WINDII data from several storms that reveal the penetration of convection-driven neutral winds to low latitudes, and Craig Hartsough (NCAR) described the approach and early results from the TIME-GCM to model the storms observed by WINDII. Ingo Mueller-Wodarg (UCL) described CTIP model results for a storm observed in Sept 1998 at Millstone Hill and outlined the sensitivity of the results to the polar ion-convection patterns. Ron Woodman (Jicamarca Radio Observatory) described electrojet observations during counter-electrojet conditions made at a time of a magnetic storm on June 8, 2000. Type I two-stream instability echoes during reverse electrojet conditions were reported.

COUPLING OF THE MESOSPHERE, LOWER THERMOSPHERE AND IONOSPHERE AT HIGH LATITUDES

Conveners: Roger Smith and Mike Kelley
(roger.smith@gi.alaska.edu; mikek@anise.ee.cornell.edu)

This workshop explored opportunities for study of the mesosphere-thermosphere-ionosphere phenomena and interactions at high latitudes and identified ideas for campaigns to take advantage of them. In Alaska, there are several new instruments in operation or at advanced stages of construction. These include the Superdarn radars at Kodiak and King Salmon, the HAARP ionospheric modification facility and its supporting ground-based suite of instruments, the ionospheric tomography array being built by Mark Conde, the instrumentation at Poker Flat Research Range, the network of Fabry-Perot interferometers, meridian scanning photometers, auroral spectrographs, magnetometers, and ionosondes. Similar arrays of instruments exist in Northern Canada, Greenland, and Svalbard.

The workshop began with a short introduction by Roger Smith, identifying the scientific scope and showing maps of the available instruments. Short talks were given on Superdarn (Bristow), HAARP and DMSP (de la Beaujardière), Tomography (Bust), Auroral currents (Zaitsev), and Polar Mesospheric Summer Echoes to be studied using HAARP (Huaman). Discussions occurred on several ideas which could be favorably pursued using facilities in Alaska:

1. Meteor winds observed using SUPERDARN and the variability of planetary waves and the semi-diurnal tide.
2. Auroral Observations by the new SSULI and SSUSI spectral imagers on DMSP and ground-based validation using the spectrometers, meridian scanning photometers, and all-sky cameras in Alaska.
3. Ionospheric dynamics in the auroral oval, the validation of the PRISM model, and the utilization of Assimilation Models.
4. The eastward electrojet development: convective versus explosive mechanisms.
5. High time resolution TEC measurements and the study of ionospheric conductivity with high spatial resolution.

Follow-up on these topics will occur off-line during the ensuing year and another meeting held at the next CEDAR Workshop.

GLOBAL IONOSPHERIC FORECASTING TECHNIQUES

Conveners: Dave Anderson, Tim Fuller-Rowell and Jan Sojka
(danderson@sec.noaa.gov; tjfr@sec.noaa.gov; fasojka@sojka.cass.usu.edu)

The GIFT (Global Ionospheric Forecasting Techniques) workshop was well attended by about 40 scientists. The theme for this year's workshop was the Auroral E region with presentations relating to (1) Ground-based and satellite-borne sensors that observe the auroral E region and (2) Empirical and theoretical models that calculate electron and ion density distributions in this region. The motivation came from the requirement for auroral conductivity within the AMIE procedures, current interest in M-I coupling, and the need for an auroral E region module for IRI. This year GIFT and HLPS (High Latitude Plasma Structures) held a joint 4-hour workshop with HLPS focusing on the polar cap region of the high latitude ionosphere.

In the GIFT workshop, ten-minute presentations were given by a number of scientists. This year the GIFT workshop had more of an exploratory nature, where the speakers were urged to highlight outstanding issues. Delores Knipp and Geoff McHarg described their work incorporating DMSP/SSJ4 energetic particle data into AMIE to improve the conductivity calculations while Dirk Lummerzheim discussed their approach to calculating conductivities using POLAR/UVI observations. Marina Galand discussed the theoretically calculated contributions to the auroral E region from precipitating energetic electrons and energetic protons and compared these with EISCAT ISR observations. Rick Doe and Ray Greenwald presented the Sondrestrom Incoherent Scatter Radar and the SuperDarn radar capabilities, respectively, while Brent Watkins and Geoff Crowley described the high latitude portion of the theoretical ionospheric models, UAF, and TIME-GCM. Finally, Andrew Nicholas and Erin Henderlight discussed very recent FUV limb-scanning auroral observations from imagers on the ARGOS satellite. The presentations and discussion reveal basic agreement between satellite-borne sensing of UV airglow and auroral particle flux and the observed response seen by the Incoherent Scatter Radars. Issues lay in maximizing spatial resolution of auroral imaging for both conductivity and M-I coupling. Lively discussions by an enthusiastic audience accompanied each one of the presentations.

The conveners of the GIFT workshop were Tim Fuller-Rowell (tjfr@sec.noaa.gov), Dave Anderson (danderson@sec.noaa.gov) and Jan Sojka fasojka@sojka.cass.usu.edu) and anyone interested in finding out more about GIFT, please contact us.

HIGH-LATITUDE CONVECTION: COORDINATION OF CEDAR AND CEDAR/TIMED SCIENCE GOALS AND EXPERIMENTAL OPERATIONS

Conveners: Mike Ruohoniemi and John Holt
(mike_ruohoniemi@jhuapl.edu; jmh@haystack.mit.edu)

The High-Latitude Convection workshop was held in the NIST Auditorium late on Monday afternoon. About 50 people attended. The workshop was the first of what may develop into a regular CEDAR session to coordinate the operations of the high-latitude incoherent scatter (IS) and SuperDARN HF radars.

The session opened with a general statement of the aims of the workshop. These include the identification of key scientific issues relating to the convection of ionospheric plasma in the high-latitude regions and the design and implementation of experimental modes suitable for their study. This was followed by a series of short presentations from Ray Greenwald, Jeff Thayer, John Foster, Hien Vo, Mike Ruohoniemi, Tony van Eyken, and John Holt. These highlighted issues in magnetosphere-ionosphere coupling, Joule heating, and disturbance electric fields that require expanded coverage of velocity effects. The current status of the facilities as related to data distribution was also discussed. Particular emphasis was laid on the value of real-time observations as a

way of identifying active periods and maximizing the value of common observations. A prototype for coordinated operations has been established between JHU/APL and Millstone Hill using the APL SuperDARN website (http://superdarn.jhuapl.edu/) for joint display of SuperDARN and Millstone Hill velocity data in near real time. In the discussion that followed each of the radar groups was encouraged to identify a person to liase with the emerging Radar Collaboratory (RC). It was suggested that velocity data from the IS radars be directed to Millstone Hill via the Madrigal database for incorporation into the real-time convection maps produced at APL. A number of technical questions relating to the distribution of data and analysis products were left to further discussion between the representatives of the several groups. A tentative timetable was set to try out the joint real-time display during World Day periods this autumn, leading to the development of a central radar mapping facility in time for the launch of the TIMED satellite. Persons interested in the development of the RC are asked to contact either of the workshop coordinators.

HIGH LATITUDE PLASMA STRUCTURES

Conveners: Cesar E. Valladares and Jan Sojka
(cesar@dL5000.bc.edu; fasojka@sojka.cass.usu.edu)

The HLPS workshop started with a brief introduction by Cesar Valladares followed by a discussion of potential topics for investigation in the next year. The introduction noted that up to five mechanisms may be responsible for the formation of polar cap patches and stressed ideas to determine the role of each of these mechanisms. Recent observations that the occurrence of patches in the Southern Hemisphere does not conform to similar statistics for the Northern Hemisphere suggests that the Southern Hemisphere patches may form in a different fashion, perhaps due to the much larger offset of the geographic and magnetic poles. There was also a discussion about investigations related to polar cap sun-aligned arcs. It was mentioned that studies on polar cap arcs should cover topics such as conjugacy of the appearance and motion of polar cap arcs. This bears on the type of magnetospheric topology that prevails when polar cap arcs are formed and the way that arcs map to different layers of the magnetosphere (e.g. LLBL, PSBL).

C. Valladares reported on principal results from the January 1999 campaign. Line-of-sight velocity measured with the Sondrestrom radar on January 20 indicated that large plasma jets occurred between 1430 and 1530 UT at latitudes where the tongue-of-ionization (TOI) was observed. In fact large densities were observed at the time that the TOI crossed the radar field-of-view. At the latitudes where the large plasma jets were observed the radar detected enhanced ion temperatures, due to Joule heating, and reduced densities, produced by enhanced recombination associated with the high Ti values. During this campaign a daytime imager was used for the first time at auroral latitudes. D. Pallamraju has already submitted a paper summarizing important results obtained using the HiTIES imager. M. Ruohoniemi spoke on the application of the SuperDARN measurements to the study of the January 20, 1999 HLPS event. The coverage of the convection velocities over the dayside region was excellent and showed areas of elevated antisunward flow. The activity could be compared with similar transients seen by the Sondrestrom incoherent scatter radar. SuperDARN products, both real-time and archival, are available from the JHU/APL SuperDARN website. The discussion that followed raised the interesting possibility of correlations between plasma structuring seen by the Sondrestrom suite of instruments and variations in backscattered power seen

by the SuperDARN radars. Santi Basu invited the HLPS community to participate in another campaign, scheduled for January 2001, aimed to study methods to forecast the occurrence and trajectory of polar cap patches. Next, P. Guzdar showed 3D simulations of plasma patch structuring, indicating that the gradient drift instability, together with secondary Kelvin-Helmholtz instability, can provide a realistic model of the observed irregularities within the patch. In the early linear phase, the basic instability begins on the steep density gradient at the edge of the patch. However, in the nonlinear phase, the instability and structuring penetrates into the core of the plasma patch thereby causing meso-scale irregularities in the entire volume of the patch. This is consistent with satellite data which show irregularity structures permeating the patch. L. Zhu presented the results of electrodynamical structurings associated with polar cap arcs from USU modeling and model-observation comparison studies. These electrodynamical structurings do not mirror the magnetospheric drivers and are determined by the ionospheric properties; these are very important to the M-I coupling study, since they reflect the active role of the ionosphere.

INTERCOMPARISON OF MEASUREMENT TECHNIQUES

Convener: Scott Palo
(palo@colorado.edu)

This workshop was convened for the first time this year and was attended by over 40 participants. Our goals were as follows:

1. To determine the level of community interest relating to the issue of systematic instrument biases,
2. To assess what has been done in this area (where do we stand?) and what needs to be done (where do we go?)

Because this was the first year for the workshop, we had an open agenda that lent itself to a vigorous exchange of ideas and opinions on the subject. It was decided that there is clearly community interest in this problem and that we should put forth an organized effort to attack it. Our first task is to compile a comprehensive list of references pertaining to middle atmosphere intercomparison studies. This list will be made available on the web; check http://odo.colorado.edu/~palo for details. Our second effort is to coordinate with the LTCS group and other members of the community to determine if there are data sets that have already been collected and would be suitable for intercomparison studies. Our final effort is to coordinate with LTCS group to draft a white paper for an intensive coordinated intercomparison campaign. It is expected that this campaign would occur at multiple CEDAR class one facilities simultaneously. If you were not able to attend this workshop and would like to be included on our email list or you have comments, questions and/or suggestions relating to our initiative, please send email to palo@colorado.edu.

ISR/UAFS: PANEL AND AUDIENCE DISCUSSION

Convener: Don Farley
(donf@ee.cornell.edu)

This was a completely open discussion about the role of the Upper Atmosphere Facilities (UAFs) in space science research, and more particularly in CEDAR activities. There was no set agenda, just a series of possible discussion questions – most of which were ignored by the audience! The panel included representatives from the four NSF-supported UAFs, plus EISCAT, and Bob Robinson from the NSF. There were probably 70 people in the panel and audience. The workshop definitely achieved its goal of having a "frank exchange of views," to use diplomatic speak, between modelers and other data users, on the one hand, and UAF staff members on the other. Both groups came away with a better understanding of each others needs and problems.

The UAFs are already working on improving data accessibility (Millstone Hill probably leads in this regard) via both the CEDAR database and individual UAF web sites. It was

pointed out to the users that they have some responsibilities too. If they have problems in getting some particular set of data, they should get in touch directly with someone at the observatory. Often a simple phone call or email can clear up a problem. Users also would benefit by learning more about how the ISR data are taken and what the limitations of various data sets are. It is sometimes not so easy to put really accurate error bars on the data. It is better to understand what the source of the errors might be. Again, direct communication can be very helpful. It was also mentioned in this regard that some users may not be observing the "rules of the road" regarding the use of database data.

Finally, a student in the audience mentioned the need for some sort of educational program (more than just a one hour tutorial or two) on the ISR technique. The same probably applies to the optical programs. We need to give some thought as to how best to do this, perhaps on an every-few-years basis.

LOWER THERMOSPHERIC COUPLING STUDY

Conveners: Roberta Johnson and Cassandra Fesen
(rmjohnsn@ucar.edu; fesen@tides.utdallas.edu)

The LTCS workshop at the 2000 CEDAR Meeting was the place to be for exciting discussion of issues facing studies of the lower thermosphere. Our workshop included over 50 attendees, and continued for almost an hour after the scheduled end time! We started off with a set of short presentations providing updates on on-going work or otherwise challenging the group. Maura Hagan (NCAR) gave an update on the status of her GSWM model. Larisa Goncharenko (MIT/Haystack Observatory) described the status of LTCS studies at Millstone Hill. Miguel Larsen (Clemson University) really heated up the discussion with his reminder that we still haven't addressed the frequent and persistent unstable shears and large winds that occur in the MLT region. Qihou Zhou (Arecibo Observatory) described recent advances in LTCS analysis at Arecibo. Finally, Irfan Azeem (University of Colorado) gave an overview of his results examining the terdiurnal oscillation at Sondrestrom, Greenland.

Following the presentations, we had an extended discussion of future plans for LTCS. We agreed to launch a new initiative for the study of lower thermospheric shears and large winds as well as a study of cross-validation of observations obtained from multiple co-located instruments during collaborative, multi-instrument campaigns centered on NSF facilities. A white paper describing this initiative is under development by the workshop co-conveners, and will shortly be forwarded to the larger core group of LTCS workers for their contributions. We also agreed we needed to identify a creative and easy to remember name for this new initiative – suggestions to the co-conveners are solicited.

MAUI/MALT: AN NSF SPECIAL INITIATIVE

Convener: Tim Kane
(tjk7@psu.edu)

This brief workshop served as an introduction of the Maui/MALT program to the community. This special NSF/CEDAR-Air Force Office of Scientific Research (AFOSR) joint initiative will fund science projects to use the AFOSR 3.67 meter Advanced Electro-Optical System at the Maui Space Surveillance Site for studies of the mesosphere and lower thermosphere. Additional information about this facility is available at http://ulua.mhpcc.af.mil/

The workshop centered on description and discussions of the ground-based instrumentation being proposed for deployment to this near-tropical mid-oceanic location atop the summit of Haleakala on Maui (20.71 N, 156.26 W, 3058 m altitude).

MAGNETOSPHERE-IONOSPHERE COUPLING

Convener: Ray Greenwald
(ray.greenwald@jhuapl.edu)

This workshop is summarized in a separate article on page 2 of this newsletter.

METEORS: PHYSICS, CHEMISTRY AND TECHNIQUES

Conveners: Qihou Zhou and John Mathews

(zhou@naic.edu; jdmathews@psu.edu)

There was a great enthusiasm for the meteor workshop in the CEDAR community. Thirteen people gave brief but very interesting presentations and there were about 70 people who attended the workshop. The topics discussed included radar and lidar observations of meteors, radar scattering mechanisms, meteor trail evolution, chemistries, and impact of meteoric materials on the ionosphere.

Following John Mathews' introduction on the radio science problems concerning meteor trails, Ron Woodman, Toshitaka Tsuda et al., and Todd Valentic presented VHF meteor observations during the Leonid meteor showers using the Jicamarca, MU, and the Resolute Bay MEDAC radar, respectively. Tom Berkey and Chad Fish discussed MF/HF meteor echo measurements using the dynasonde system located in the Bear Lake Observatory. Frank Lind et al. presented the passive observations of meteor echoes scattered from commercial TV/radio stations. Meers Oppenheim and Lars Dyrud discussed theoretical simulations of meteor trail evolution and their potential implication for radar scattering above ~100 km. John Plane started the second part of the workshop with an introduction on meteoric chemistries. Franz-Josef Luebken highlighted lidar meteor observations at the Leibniz-Institute of Atmospheric Physics in Germany. Xinzhao Chu et al. presented ground-based and airborne lidar observations of meteor trails by the University of Illinois group. Tim Kane explained a video clip of the lidar observations made at the Starfire Range. Thirty minutes into the break, Qihou Zhou finally got a chance to show some ionospheric effects due to meteoric ionizations. Discussions continued throughout the break and the conference among some of the participants. The one hour break between workshops was great and, we hope, will be kept for future afternoon workshops as well.

At the workshop, we handed out a questionnaire to gauge people's interest in future meteor workshops. Practically every one in the workshop favored an annual workshop at CEDAR. Fifteen people were interested in attending a meteor workshop if it is held at Arecibo in the next two years. Six people definitely wanted to, and eight people might, contribute a paper to a special issue of Radio Science or JASTP. We will contact the editors of the two journals for a special issue on meteoric science in due time. If you were not at the meteor workshop, or missed the sign-up, and are interested either in future workshop information or in contributing a paper to a special issue of Radio Sci. or JASTP, please let either of us know. Some information on meteoric research can be found at http://www.naic.edu/~zhou/meteor.

MILLSTONE HILL OBSERVATORY WORKSHOP

Convener: John Holt

(jmh@haystack.mit.edu)

A sampling of recent Millstone Hill scientific results and development projects was presented by Observatory staff members. A primary goal of the Workshop was to introduce the CEDAR community to some of the newer members of the Observatory and their research, and to encourage new collaborative efforts utilizing Observatory instruments and archived data. More information on the Observatory and email addresses of the speakers are available at http://www.haystack.edu.

PLANNING WORKSHOP FOR THE 2001 CO-ORDINATED INCOHERENT SCATTER OBSERVATION DAY CALENDAR

Convener: Tony van Eyken

(Tony.van.Eyken@eiscat.com)

The Co-ordinated Incoherent Scatter Observation Day Calendar is prepared each year by the URSI Incoherent Scatter Working Group (ISWG) and the annual planning workshop at the CEDAR meeting makes an important input to the process.

This year, the workshop was the very last formal session of the CEDAR

meeting. Nevertheless, about 15 people were still left to participate in the shortest workshop of the meeting. Most of the input from other working groups had already been assimilated prior to the workshop. After the addition of some late requests, the proposed observations exceeded the total number of days available in 2001 (nominally 21) but the workshop quickly agreed to correct this by merging several programme requests. A more serious problem involved the increasing number of "floating" observations (i.e., those whose exact timing is to be decided close to the observation dates using, for example, prevailing geophysical conditions) which cause operational difficulties, particularly at Arecibo. The requested floating intervals were retained in the draft calendar, but with the provision that Arecibo would probably operate during the default intervals.

The draft calendar prepared at the workshop will be available on the WWW (see below) for further comment. Final modifications will be included in early September, after the orbits of the CLUSTER spacecraft were determined. Thereafter, the schedule will be dispatched for inclusion in the 2001 International Geophysical Calendar.

The current draft of the 2001 calendar can be found at http://www.eiscat.uit.no/URSI_ISWG/2001_schedule.html; comments/suggestions should be sent to the Chairman of the URSI ISWG (Tony.van.Eyken@eiscat.com)

POLAR MESOSPHERIC DYNAMICS

Convener: Thomas Duck
(tomduck@haystack.mit.edu)

The first CEDAR workshop on "Polar Mesospheric Dynamics" covered a range of topics, and sparked some lively debate. The workshop was organized by Tom Duck (tomduck@haystack.mit.edu) and a detailed Web page for it may be found at http://www.haystack.mit.edu/~tomduck/cedar_ws/. The discussions focussed primarily on the heat and momentum budgets of the polar mesosphere. The observed structure of the wintertime polar vortex was discussed, and the TIME-GCM was shown to simulate the thermal effects of vortex movements reasonably well along with the annual variation in mesopause height. Planetary wave and gravity wave induced circulations were considered. A warming in the vortex core was attributed to driving by observed increases in gravity wave activity, although planetary wave dynamics may also have a role. During a planetary wave driven disturbance, observations in the upper mesosphere revealed cooling. Measurements of turbulent dissipation were shown to indicate that mesospheric heating rates are (paradoxically) highest during the polar summer (when the temperatures are coldest). Comparisons of the thermal structures between poles were also addressed, as was the possibility for observing polar mesospheric clouds at mid-latitudes. The workshop highlighted that there are many uncertainties regarding our understanding of polar mesospheric dynamics. Models may be able to help evaluate the relative contribution of each dynamical process. Further observations are also needed at other polar sites. The CEDAR 2000 workshop on "Polar Mesospheric Dynamics" has provided a starting point for a variety of studies.

RECENT STUDIES OF NEUTRAL DYNAMICS

Convener: Tim Kane
(tjk7@psu.edu)

The CEDAR community annually selects a handful of scientific achievements from the past year to highlight in the morning sessions of our meeting. This year, the number of excellent speakers who were nominated exceeded the available morning slots. Since many of these had a common theme of neutral dynamics, it was decided to present them in this afternoon workshop. Announced up front as "AGU-like" in nature, this session proved quite successful, eliciting brisk interaction from the standing-room-only audience. The speakers and their topics are listed below; the symbol at the end of each item is keyed to the list of Conclusions/Action Items that follows the list of speakers.

• John Meriwether, who presented a review of the mesospheric inversion layer phenomenon (e.g., Meriwether and

Gardner, J. Geophys. Res., v. 105, p. 12405, 2000) *

• Miguel Larsen, who presented a large accumulated data set of recent and historical observations of persistent large winds and unstable shears in the E-region #,%,§

• Anne Smith, who discussed recent work on the terdiurnal tide (e.g., Smith, Geophys. Res. Lett., v. 27, p. 177, 2000) *,#

• Chris Meyer, who presented an investigation of planetary-wave penetration into the thermosphere (e.g., Meyer, J. Geophys. Res., v. 104, p. 28,181, 1999) §

• Maura Hagan, who discussed the recent PSMOS workshop, then presented some fresh global scale radar observations of northern hemisphere tidal variability (organized by Pancheva and Mitchell, Aberystwyth) *,%

Conclusions/Action Items

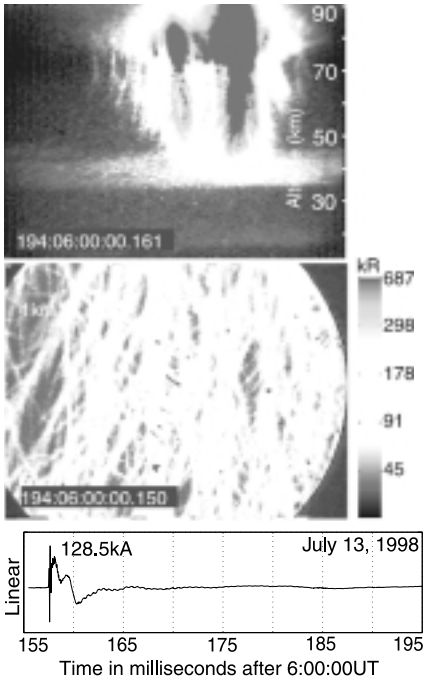
* 24 hour observations are required
# Importance/need to assimilate data
% Wind measurements a priority
§ Continue efforts to resolve differences between models and observations

The PSMOS effort (a SCOSTEP project; http://www.hao.ucar.edu/psmos/home.html) ties together a great deal of the above material; the session appropriately ended on this note, which leads us forward to next year's joint CEDAR/SCOSTEP meeting!

TRANSIENT OPTICAL EMISSIONS IN THE UPPER ATMOSPHERE

Conveners: Matt Heavner, Victor Pasko and Mike Taylor
(heavner@lanl.gov; pasko@nova.stanford.edu; mtaylor@cc.usu.edu)

The Transient Optical Emissions in the Upper Atmosphere workshop was proposed to discuss three main topics: the Severe Thunderstorm Electrification and Precipitation Study 2000 (STEPS 2000); the total energy dissipated into the middle- and upper-atmosphere by sprites; and recent experimental and theoretical studies of sprites and other thunderstorm effects in the upper atmosphere. After a brief introduction to phenomenology (Matt Heavner) and theory (Victor Pasko), Hiroshi Fukunishi began the workshop by describing observations of sprites and elves over winter thunderstorms occurring in Japan. One surprising result is the low altitude of the storms with radar reflectivity to only 5 km. With sprites associated with positive cloud-to-ground (CG) lightning discharge of only approx. 60 C (as reported by the Japanese Lightning Detection Network), the inferred charge moment is quite low compared to observations of sprites over the central United States. Matt Heavner presented calculations of total energy deposited in the middle atmosphere by a typical sprite based on optical spectral observations and lab measured fractional electronic and vibration excitation. Depending on the importance of inter-system collisional transfer processes, the energy deposited is calculated to be between 250 MJ and 1 GJ. Steve Cummer and Victor Pasko both presented electrostatic calculations that only 10-40 MJ of energy is available from the discharge of the thunderstorm fields by a positive CG. Elizabeth Gerken presented telescopic imaging and VLF magnetic observations of sprites from the 2000 summer campaign. One example of Elizabeth's recent observations is shown in the accompanying figure, reproduced from Gerken, E. A., U. S. Inan, and C. P. Barrington-Leigh, Telescopic Imaging of Sprites, Stanford University pre-print, 2000. Mark Stanley described the STEPS 2000 campaign and commented on the surprisingly large percentage



(approx 50%) of storms with "inverted" polarity.

Mark also presented the New Mexico Tech lightning mapping array (LMA) observations of a sprite-associated positive CG. Tom Nelson tied together sprite, lightning, and weather radar observations to report on a storm with several sprites occurring very near the active convective core of the storm, rather than over the stratiform region. Tom presented several interesting events highlighting the need for more lightning data - one event with 5 distinct sprites observed had only 3 NLDN events reported. Chris Barrington-Leigh presented analysis of multi-instrument observations of one of the brightest observed sprites. Using typical nitrogen emissions from sprites, Chris estimated the total optical emissions to be 620 MR. Chris also discussed halos and elves, specifically the two different proposed mechanisms for sprite production; one leads to structured optical emissions, the other to the more diffuse halo emission. Chris concluded that either or both mechanisms may occur with a single CG, but that halos are "an integral part of the sprite process". Victor Pasko presented the application of Niemeyer's fractal model of streamer corona to describe sprite breakdown processes and structure. One point of interest was the prediction of similar complex structure for both single and multiple initiation points. Larry Gardner presented initial results of the first observations of sprites over Europe during observations of the Leonid meteor storm. No coincident meteor/sprite observations were reported however. One very nice feature in the observations Larry presented was the clear observation of the "hole" in the middle of the elves. Steve Cummer discussed the relationship between the delay between the parent CG and the sprite initiation and the altitude at which initiation occurs (as well as the large required charge moment needed for initiation of optical emissions). Additionally, using different conductivity profiles, Steve described why much larger charge moments are necessary for initiation of daytime sprites. Fernanda Sao Sabbas presented detailed analysis of triangulated sprite location and the NLDN reported location of the parent CG finding a large offset spatially.

The workshop was very successful in informing attendees of current developments in observations, analysis, and theories of transient luminous events in the middle atmosphere. We anticipate a similar session at the 2001 CEDAR workshop. Please contact any of the conveners with questions regarding the 2000 session or suggestions for the 2001 session.

TOPSIDE IONOSPHERE

Conveners: Sixto Gonzalez, Phil Erickson, Robert Kerr and John Noto

(sixto@naic.edu; pje@haystack.mit.edu; bob@sci-sol.com; noto@sci-sol.com)

Discussion of optical and radar techniques related to observations of the topside ionosphere and neutral exosphere were the highlights of this year's CEDAR topside workshop. Presentations included:

- John Noto (SSI) with updates on Fabry-Perot interferometers and automated photometers being constructed for exospheric measurements by SSI;
- Susan Nossal (U. Wisconsin) with an overview of neutral hydrogen measurements using WHAM astrophysical geocorona data, and updates on extracting hydrogen density profiles from H-alpha intensities using James Bishop's model;
- Ed Mierkewicz (U. Wisconsin) with a description of using Hydrogen beta emissions as an alternative to measuring neutral hydrogen;
- Phil Richards (U. Alabama - Huntsville) with FLIP model comparisons to Millstone Hill radar data during the January 1997 geomagnetic storm;
- Sixto Gonzalez (Arecibo) with updates on Arecibo topside measurements;

• Mike Sulzer (Arecibo) with updates on the use of electron-electron collisions in correcting the theoretical IS spectrum for use with Jicamarca data;

• Stan Solomon (U. Colorado) with SNOE measurements and models of solar soft Xray flux;

• Andrey Litvin (Boston U.) with analysis of IS data for hot oxygen levels;

• Phil Erickson (Millstone Hill) with updates on the POLITE world day campaign and the availability of Kharkov, Ukraine topside radar data.

For more information about topside issues, you can visit the web sites http://www.haystack.mit.edu/polite or http://www.naic.edu/~sixto/workshop.html or you can contact any of the conveners directly at the email addresses above.

WAVE DUCTING IN THE MLT REGION

Conveners: Mike Hickey and Jim Hecht
(hickey@hubcap.clemson.edu; james.h.hecht@aero.org)

This workshop was held on Thursday afternoon (June 29), starting at 1 p.m. and finishing around 5:45 p.m. Attendance was very good (sixty to eighty people), and the workshop had a real workshop atmosphere, bearing little resemblance to an AGU meeting. Discussion prevailed, ideas and opinions were exchanged quite freely, and most people left the workshop with a sense of learning something new.

Initial reviews of wave ducting were given by Richard Walterscheid (theory/modeling) and by Jim Hecht (observations). Both of these referred to airglow imager observations made at Adelaide, Urbana, and Shigaraki, Japan, which show an azimuthal anisotropy of wave propagation that is predominantly poleward in summer and equatorward in winter. Tai-Yin Huang presented some modeling results pertaining to the ALOHA-93 campaign. Mike Taylor presented more imager observations, again showing the preferred propagation directions of ducted waves, and also discussing some morphological differences between “banded” wave structure and “ripples” in the airglow. Gary Swenson also discussed his imager observations of many waves, some of which fall into the ducted category. Dave Fritts discussed some theoretical reasons why some of the small scale waves could be ducted. Alan Liu discussed Starfire lidar observations with respect to the presence of instability structure in the atmosphere. Miguel Larsen discussed TMA release measurements of large, unstable wind shears in the MLT region, and how this may be the generator of Kelvin-Helmholtz instabilities. Mike Hickey finished with a numerical simulation of the “Kelvin Cat's Eye”, Kelvin-Helmholtz instability, showing how it would appear wavelike in the airglow. Numerous other people added significantly to the workshop by their useful comments. We thank everyone for participating and making this a most enjoyable experience.

Day observing time. It was pointed out that the previous WLS runs have been very successful in hitting disturbed intervals - so much so that major storms, rather than substorms, have been the dominant topic being investigated with the WLS data sets. A serious suggestion to change the name of the working group was discussed and adopted. Henceforth, the WLS Group is the CEDAR Wide-Latitude Storm study group. The most significant attribute of the continuing experimental program is the flexibility and communication among the radar facilities that enables the operations to zero in on disturbance intervals. Most recently, the July 15/16, 2000 major event was covered by Sondrestrom, Millstone Hill, and Irkutsk giving good latitude and longitude coverage of that storm interval. Real-time monitoring of solar and solar-wind conditions, and educated "predictions" were used in posting the storm alert and in scheduling the radar coverage at the radar sites. Such coordination will continue throughout this solar maximum period. It was agreed to continue the WLS working group and to request two World Day intervals in 2001. [At the subsequent World Day scheduling meeting, it was agreed that one of these intervals would be "fixed" and one "floating."]

MEETINGS CALENDAR

2000

Sept 4-8	First European Conference on Radar Meteorology, Bologna, Italy
Oct 2-6	First S-RAMP conference, Sapporo, Japan
Oct 9-12	SPIE's symposium on Remote Sensing of the Atmosphere, Environment, and Space, Sendai, Japan
Oct 22-25	Remote Sensing 2000: From Spectroscopy to Remotely Sensed Spectral Observations, Corpus Christi, TX
Oct 23-25	ISTP Workshop, UCLA, CA
Oct 27-29	Space Weather Study Using Multi-point Techniques, Taiwan, China
Oct 30-Nov 3	Huntsville Workshop on A New View of Geospace: Integration, Interpretation, and Synthesis, Pine Mountain, GA
Nov 6-10	2nd SPARC General Assembly: Stratospheric Processes and their Role in Climate, Mar del Plata, Argentina
Dec 15-19	AGU fall meeting, San Francisco, CA

2001

March 12-16	AGU Chapman Conference on Storm-Substorm Relationships, Lonavala, India
Apr 8-12	European Union of Geosciences (EUG) XI, Strasbourg, France
Apr 16-20	AGU Chapman Conference on Low Latitude Boundary Layer and its Dynamical Interaction with the Solar Wind and Magnetosphere, New Orleans, LA
May 29-June 2	AGU spring meeting, Boston, MA
June 13-16	International Solar Cycle Studies 2001 - Solar Variability, Climate, and Space Weather Symposium, Longmont, CO
June 17-23	CEDAR Workshop and SCOSTEP STP-10 Symposium, Longmont, CO
June 17-21	SHINE workshop, Snowmass, CO
June 17-23	GEM meeting, Snowmass, CO
August 18-30	IAGA 9th Scientific Assembly and 30th IASPEI General Assembly, Hanoi
Sept 10-12	Solar Terrestrial Magnetic Activity and Space Environment, Beijing, China
Dec 10-14	AGU fall meeting, San Francisco, CA

2002

May 28-June 1	AGU spring meeting, Washington, DC
Oct 11-20	COSPAR World Space Congress, Houston, TX
Dec 6-10	AGU fall meeting, San Francisco, CA

SURVEY ON THE ANNUAL CEDAR MEETING

The CEDAR Science Steering Committee would like your comments on the annual CEDAR meeting. A survey is printed below; it can also be answered electronically at http://cedarweb.hao.ucar.edu/wkshp/survey00.html.

We would appreciate ANY input, however brief (or long!). You can pick and choose the items to critique/answer, or go right to the bottom and give any comments you'd like. Questions 1, 2, and 3 summarize most of the issues if you just want to concentrate on those.

Thanks for any feedback!

– The CEDAR Science Steering Committee

CEDAR Meeting Survey

1. How important are the following in deciding whether you will attend the CEDAR meeting?
   Use a scale of 0 to 5, with 0=Not important, 5= Very important
   ___ Meeting Location
   ___ Meeting dates
   ___ Scheduled talks at the meeting
   ___ Scheduled workshops at the meeting
   ___ Other factors? Like what?

2. How good/useful/important are the following elements of the meeting?
   Use a scale of 0 to 5, with 0=Not useful/important, 5= Very useful/important
   ___ CEDAR Prize Lecture
   ___ Tutorials
   ___ Science Highlights
   ___ Programmatic Items (e.g., NASA, TIMED, Space Weather program reports)
   ___ Workshops (also see questions 5 and 6 below)
   ___ Poster session(s) (also see question 7 below)

3. Any particular preference for or comments on
   a) when the meeting is held?

   b) where the meeting is held?

   c) Given a choice between NOAA/NIST (where we met this year) and U. of Colorado (where we met previous years), which do you prefer?

4. A number of people complain that there is very little time to meet and talk informally.
   a) This year, we tried to alleviate this by having the afternoon breaks be one hour long. Should we keep that? _____
   b) Should we schedule "free time" — that is, a period when we don't have any workshops or sessions? _____
      If yes, what do we eliminate?
      - one or more morning sessions
      - one or more afternoon sessions
      Or do we schedule one or more evening sessions?
   c) Any other ideas on how to provide some unstructured time?

5. Typically there are three, sometimes four, afternoon workshops per day.
   a) Should we limit the number of workshops to cut down on the overlap? _____

      If yes, how do we do this? That is, how do we decide which workshops are scheduled and which are rejected?

   b) Should two hours be the default length for the workshops? _____

   c) There are frequent complaints that the workshops are not workshops but AGU sessions. Any suggestions on how to alleviate this?

6. Any comments on the CEDAR Database workshop?
   Such as, but not limited to, the following:
   Is it useful? _____
   If you attended this year, did you like having data providers do demonstrations and answer questions? _____
   What would you like to see/do at these sessions?

7. The CEDAR meeting always includes one or more poster sessions, usually in the evenings.

a) The poster session(s) should be retained.	No	Yes
b) The poster session should be split into two viewing periods (as it was this year).	No	Yes
c) The student posters should be judged and prizes awarded.	No	Yes
If yes, should we give out		
- first, second, and third place awards? OR	No	Yes
- an indeterminate number of "Outstanding Poster" citations?	No	Yes

8. Any comments on the meeting logistics, such as...
   Registration fee
   Breaks
   Meeting accommodations (i.e., where the AM and PM sessions are held)
   Hotels (selection, price, etc.)
   Transportation to/from airport
   Transportation at the meeting (shuttles, etc.)
   Extracurricular activities
   Other

9. The best thing about the CEDAR meeting is...

10. The worst thing about the CEDAR meeting is...

11. Any other comments? Suggestions? Complaints?

Please send your responses by whatever means is most convenient to

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