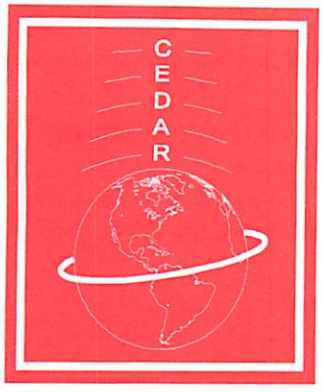


# The CEDAR Post

August 1998 Volume 34

## FROM THE STEERING COMMITTEE

The June 1998 CEDAR meeting was another productive and successful forum for interactions by our community. This issue of the Post presents summaries of the meeting highlights and the workshops convened at the meeting.

A new membership list of the CEDAR Science Steering Committee (CSSC) for 1998-1999 is given on page 2. Cassandra Fesen (University of Texas at Dallas) was appointed to the committee and will chair it starting at the end of the next CEDAR meeting in June 1999. Jean-Pierre St. Maurice (University of Western Ontario, Canada) will be one of the two international representatives on the CSSC. Roger Smith (University of Alaska) has been appointed to serve as a liaison with the GEM community and will also serve on the GEM Steering Committee. Andrew Stephan (Boston University) will be the student representative for 1998-1999. We thank Michael Mendillo, Gordon Shepherd and Julie Chang who completed their terms on the CSSC in June 1998.

The CSSC will meet at NSF on November 13 in order to review CEDAR issues and to begin planning for the 1999 meeting. The progress at NCAR on the access to the CEDAR database through the WWW will be reviewed. Early results from a survey of CEDAR graduate students organized by Dave Hysell [*dhysell@clemson.edu*] in response to a request by NSF to the CSSC will be discussed. We urge you to respond to Dave's request for help in contacting former students. The survey is available through *http://landau.phys.clemson/SURVEY.html*.

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The **1999 CEDAR meeting will be held on 14-18 June 1999 in Boulder**, with a student workshop on June 13. Consideration is being given to the allocation of additional time for workshops at the 1999 meeting by eliminating one of the morning sessions. Consideration is also being given to the possibility of a joint CEDAR/GEM/SHINE mini-workshop in Snowmass over the weekend of 19-20 June 1999, pending the development of a scientific theme for the workshop. A proposal for a co-located meeting with GEM and SHINE is being discussed for the year 2000, subject to the selection of a suitable location. If you have any input or suggestions about these matters, please contact any member of the CSSC.

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## STATUS OF THE POLAR CAP OBSERVATORY

On 10 June 1998, during the CEDAR meeting, we learned the decision of the Senate Appropriations Committee to deny funding for the Polar Cap Observatory under the NSF Major Research Equipment program for FY99. The Committee did not remove the $21M requested for the PCO from the NSF budget, and additionally inserted $24M for Arctic logistics support.

The CEDAR community promptly prepared a letter to the Chairman of the House Appropriations Subcommittee (Representative Jerry Lewis, CA) which has jurisdiction over the NSF budget, asking that the PCO project be judged on the basis of its scientific merit and requesting that the House approve the funding. The letter was signed in a petition format by 112 members of the community who were still assembled on June 12, the last day of the meeting. Copies of the letter were faxed to Representatives George Brown (CA) and Vern Ehlers (MI) who are congressional champions of science, as well as to the director of the National Science Foundation and to the Chair of the National Science Board which had approved the project.

Dr. Richard Greenfield, Director of the NSF Division of Atmospheric Sciences and a strong advocate of the PCO, made a presentation to the CEDAR attendees at a plenary session on June 12. Many members of the community expressed their strong disappointment with the PCO situation and urged the NSF leadership to fight harder for the PCO and to communicate urgently with Senator Stevens (AK) and his staff in order to settle the PCO controversy.

The House Appropriations Committee met on June 25 and decided also to deny the funding for the PCO in FY99. The House Committee's formal report says that "this action is taken reluctantly and without prejudice", and states that "the Committee has been a strong proponent of the project and believes the science to be achieved could go far toward enhancing our understanding of the conditions in the space environment..." The committee indicated its willingness to support funding for PCO at the earliest possible time if the concerns currently holding up the project are resolved.

These events have stunned our community since the project, developed as a grass-roots effort, has followed all proper processes for peer-review and approval by the NSF. We must remain hopeful that the NSF leadership will work towards the resolution of the issues by direct communications with Congress. At the time that this newsletter goes to press (31 July 1998), there is no further information to disseminate or actions to recommend. If the issues are resolved satisfactorily, the next possibility for reinstatement of the funds for the PCO is during the Senate-House Conference Committee review of the NSF budget. The membership of this committee and the date of the meeting are not presently known. Indications are that the meeting will likely take place in September.

As noted in the 7 July 1998 AGU/SPA newsletter, "it is unlikely that the Appropriations committees will change their views on funding the PCO unless they receive a chorus of support for the facility." At the appropriate time, the CSSC will be calling again on the CEDAR community and the science community at large to produce this chorus of support by writing to the conference committee members. The number of letters received counts heavily in Congress, and we encourage everyone to respond since the PCO is vital to the health of our overall discipline and we must preserve the principles associated with its funding process.

*Joseph E. Salah, CSSC Chair*

## KILE BAKER BECOMES NEW PROGRAM DIRECTOR FOR MAGNETOSPHERIC PHYSICS AT NSF

In May of this year, Dr. Kile Baker took over as Magnetospheric Physics Program Director at the National Science Foundation. Dr. Baker is on a leave of absence from Johns Hopkins University's Applied Physics Laboratory where he conducted research using the SuperDARN high frequency radar network. His extensive experience in ground-based studies of magnetospheric processes, many in coordination with simultaneous satellite observations, makes him well-suited for this position. Dr. Baker replaces Dr. Robert Clauer, who returned to his position in the Space Physics Research Laboratory at the University of Michigan.

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## CEDAR'S HUAILIN CHEN WINS OSA'S ALLEN PRIZE

In the May 1998 issue of Optics & Photonics News, the Optical Society of America 1998 Awards were announced. The Allen Prize for outstanding contributions to atmospheric remote sensing while a graduate student, was awarded to Huailin Chen, a recent CEDAR-supported student, for his novel design and implementation of an ultra-narrow Faraday filter, which permits continuous, high quality, daytime measurements of mesospheric temperatures by suppressing the detected sky background by a factor of 6000.

Chen received his B.S. and M.S. in Quantum Electronics from Peking University, Beijing, China, and his Ph.D. in Physics in 1997 from Colorado State University. Chen is presently a Research Scientist at NASA/Goddard Space Flight Center working on double edge-etalon aerosol wind lidar.

The Prize will be given at the 1998 OSA Annual Meeting in October in Baltimore.

*Joe She, Colorado State University*

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## CEDAR POST-DOCTORAL FELLOWSHIPS FOR 1998-2000

NSF made two CEDAR post-doctoral awards in 1998:

- **Onder Kivanc**, University of Texas at Dallas, sponsored by Cassandra Fesen.
  Project: "Upper Boundary Conditions in the NCAR TIEGCM".

- **Ludger Scherliess**, Utah State University, sponsored by Bela Fejer.
  Project: "Empirical Electric Field Model".

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## NSF GRANT AWARDS FROM FY1998 CEDAR COMPETITION

**University of Alaska: R. Smith and M. Conde**; Clustered Measurements of Space and Temperature Variability in the Winds of Upper Mesospheric and Upper Thermospheric Heights in the Auroral Zone

**Collaborative Research:**
**Boston College: C. Valladares**; MISETA - Ion-Neutral Coupling
**Boston University: M. Mendillo**; Imaging Science Component of the MISETA Program
**Clemson University: J. Meriwether**; MISETA - Continued Equatorial FPI Observations of Winds and Temperatures to Solar Maximum, 2001

**Colorado State University: C-Y She and D. Krueger**; Improved Continuing Lidar Observation and Geophysical Study of the Mesopause Region

**University of Colorado: R. Akmaev**; Atmospheric Response to Perturbations in Greenhouse Gases with a Spectral MLT Model

**University of Colorado: T.J. Fuller-Rowell and R. Akmaev**; The Influence of Lower Atmosphere Forcing on the Composition Structure of the Thermosphere

**University of Colorado: D. Thorsen**; Comparative Mesospheric Gravity Wave Activity Observed Along a Chain of Sub-Tropical to Mid-Latitude MF Radars

**Cornell University: M. Kelley**; Clustering of Instruments for Studying Long-Enduring Meteor Trails

**Embry-Riddle Aeronautical University: G. Sivjee**; Identifying Planetary Waves and Migrating/Nonmigrating Tidal Oscillations at Latitudes Using a Longitudinal Chain of Airglow Optical Instruments

**University of Illinois: G. Swenson**; Imaging Studies of Mesospheric Gravity Waves

**MIT: J. Foster and P. Erickson**; Kharkov Radar Studies of Light Ion Characteristics in the Topside F Region

**MIT: J. Salah and D. Sipler**; **J. Meriwether, Clemson University**; Thermospheric Coupling with the Lower Atmosphere Using Lidar and CEDAR Instrument Cluster at Millstone Hill

**Scientific Solutions, Inc.: R. Kerr**; Clustered, Multi-Frequency Studies of the Thermosphere, Exosphere, and Topside Ionosphere

**SRI International: T. Slanger**; The New Oxygen Nightglow

**SRI International: J. Thayer**; Height-Resolved Joule Heating Rates and the Influence of Neutral Winds

**SRI International: R. Tsunoda**; Low-Latitude Electrodynamics

**Utah State University: V. Wickwar**; The Mesosphere and Lower Thermosphere Using the USU/CASS Atmospheric Lidar Observatory

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## SUMMARY REPORT: 1998 CEDAR Meeting

The 1998 CEDAR Meeting was held between Sunday June 7 and Friday June 12 at the University of Colorado in Boulder. A total of 295 persons from 73 institutions, 14 outside the United States and Puerto Rico attended the CEDAR Meeting. There were 39 universities represented and 34 research laboratories, including 10 small businesses.

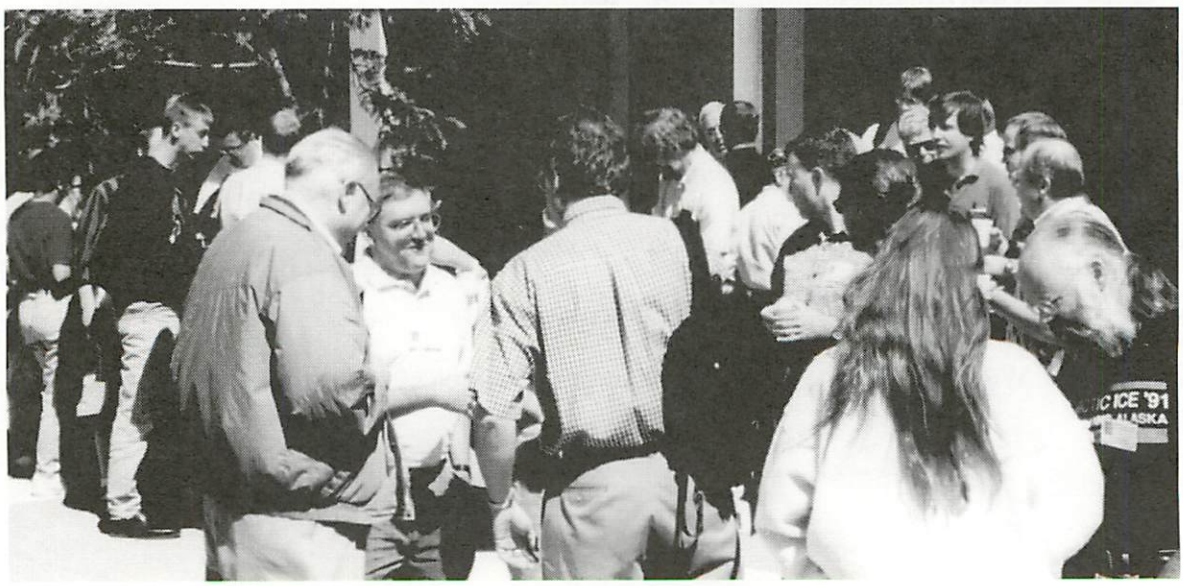
This year, 104 students came from 28 universities and 3 research labs, including one student each from Canada and the United Kingdom, and 4 students from Taiwan. Of these students, 25 were undergraduates. The number of researchers attending the meeting in 1998 was about 6% larger than 1997, there were 11% fewer graduate students and 39% more undergraduate students. The total number of attendees was similar to that in 1997.

The CEDAR Prize lecture was given by Gary Swenson of the University of Illinois on 'A Model for Calculating Acoustic Gravity Wave Energy and Momentum Flux in the Mesosphere from OH Airglow'. Timothy Fuller-Rowell of the NOAA Space Environment Center gave a tutorial on 'Polar Aeronomy: Thermosphere-Ionosphere Interactions above 100 km', while Michael Mendillo of Boston University spoke on 'Equatorial Aeronomy'. Guy Brasseur of the Atmospheric Chemistry Division of NCAR gave a tutorial on 'Atmospheric Changes due to natural variability and anthropogenic effects', and Art Hundhausen of NCAR's High Altitude Observatory gave a tutorial on 'Coronal Mass Ejections'. Hard copies of the transparencies and slides are available, as are videotapes of these talks. Please contact Barbara Emery (*emery@ucar.edu*), if interested in obtaining copies.

There were nine 20-minute science highlight talks by members of the community, and 14 reports on various programs. There were 21 workshops, some of which are reviewed elsewhere in this issue. The fifth annual student workshop on Sunday was organized by the CEDAR student representative Julie Chang of the University of Colorado, who also organized the first student social, which was a big success. About 55% of the students attended the Student Workshop and social.

A total of 55 posters were shown in the Glenn Miller Ballroom of the University Memorial Center Tuesday afternoon, where the reception started around 3:30 PM. The posters were arranged in 5 topics. Student presenters gave 29 posters, including one undergraduate student, Katelyn Allers of Whitworth College. The first place student poster prize went to Simon Shepherd of Dartmouth College for his poster on 'Ionospheric Structure during Auroral Ionospheric Electron Cyclotron Emissions'. Second and third prizes went to Laura Peticolas of the University of Alaska and to Jean-Marc Noel of the University of Western Ontario, our first Canadian poster prize winner.

*Barbara Emery, HAO/NCAR*




*All Photos Courtesy of Ed Dewan*

*Workshop Report:* **ISR World Day Schedule for 1999**
*Convenor:* **A. van Eyken**

The 1999 Schedule for coordinated Incoherent Scatter Radar observations was discussed at the 1998 CEDAR Workshop. About 15 to 20 people came to discuss the first draft of this calendar. The proposed calendar for 1999 is posted at
*http://www.eiscat.no/URSI_ISWG/1999_schedule.html.*
The calendar could evolve as further discussions at held at other meetings, and the final version will be posted at the above address and published in September as part of the International Geophysical Calendar.

For those interested in the planned coordinated observations for the remainder of 1998, the International Geophysical Calendar for 1998 may be found at *http://www.sec.noaa.gov/ises/calendar/calendar.html.*

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*Student Workshop Report:* **Communicating with One's Peers**
*Convenor:* **J. L. Chang**

The main focus of this year's workshop was to provide a forum for people with common interests but different areas of expertise to improve their communication skills. The workshop, held on Sunday, 7 June 1998, was attended by 75 people, 22 of them being non-students. There were 2 parts of the student workshop: an afternoon session with speakers and an evening social.

The afternoon session started with an hour talk on pre-writing and on how to prepare oral presentations. Patricia Weis-Taylor of the University of Colorado talked about basic techniques that can be used for writing most documents. Some of the points she focused on were how to identify the purpose of the paper as well as the audience, how to develop a thesis statement, and how to use mind maps and tree diagrams to organize a paper. In addition to the pre-writing process, she also gave a brief talk on how to prepare effective oral presentations.

Following the pre-writing talk, several CEDAR graduate students and recent graduates gave brief overview talks on some of the CEDAR instrumentation and models. The CEDAR instruments discussed included a variety of radars such as lidars, ISR, MST, MF and meteor radars, as well as the UARS/HRDI and Fabry-Perot interferometers. In general, each instrumentation speaker discussed how their instrument worked, what it measured and the geophysical phenomena which could be quantified from this measurement, and the advantages and disadvantages to using the instrument. For the TIME-GCM and GSWM models, the speakers discussed what geophysical parameters can be modeled, what inputs are needed for the model, the limitations of the model as well as the basic theory on which the model is based. Copies of some of the speakers' transparencies will be made accessible at
*http://grison.colorado.edu/~changj/cedar.html.*

The evening social at the Chautauqua Arbor Picnic Shelter gave students and invited guests a chance to interact in an informal setting. Approximately 65 people showed up, including family of some of the local tutorial speakers. Time was spent getting acquainted with one another, eating a lot of food, exploring the hiking trails, and playing frisbee. The overall response to the talks and the social was very positive. Many students found the information useful during the rest of the CEDAR workshop as well as for future reference.

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*Workshop Report:* **Lidar: Overview, Progress and Updates**
*Convenors:* **R. Collins, J. Friedman**

The lidar workshop was divided into two sessions a plenary with four invited presentations and a technical session that featured shorter presentations from each of the CEDAR lidar groups. The plenary presentations were: lidar introduction and overview, narrowband lidar, lidar flux measurements, and future directions for CEDAR lidar. The introduction provided an overview of the types of measurements CEDAR lidars make and the techniques by which those measurements are made. Results from the various lidar groups were provided with examples of how lidars can coordinate with other CEDAR instrumentation to measure atmospheric phenomena. The narrowband lidar presentation covered the principle and practice of the narrowband metal lidar in two operational modes:
(1) Two-frequency operation for measuring metal density and atmospheric temperature in the mesopause region, and
(2) Three-frequency operation for measuring metal density, atmospheric temperature and line-of-sight wind in the mesopause region.

Studies based on these lidar observations were used to demonstrate that exciting and potentially exciting geophysical information may be extracted from these measurements. The audience was cautioned on the cares necessary to maintain the system in stable operation conditions. On-going technological and spectroscopic developments which will make accurate wind measurement as well as daytime measurement possible are also discussed. The presentation on flux measurements focused on lidar measurements of vertical heat fluxes <w'T'>. Recent measurements suggest that the wave-driven components of these fluxes may be significantly more important in the mesospheric circulation than previously realized. These measurements are particularly challenging due to the inherent geophysical variability in the measurement, which dominate the measurement uncertainties regardless of the particular measurement method. The final presentation addressed the future role of lidars in the CEDAR community. Based on an informal survey of various scientists, five broad topics were discussed:
1) Observational Strategies: Lidar observations need to concentrate on long-term data sets, clustering with other instruments and synergy with satellite observations.
2) Continue on Current Course: The flux measurements as well as chemistry/dynamic studies should continue. "Golden Oldies" like simple metal density resonance systems as well as density profiling Rayleigh lidars should be included as well.
3) Mobile Lidar: To fill in the latitudinal/longitudinal gaps in 'Chain' observations as well as for providing flexibility to explore new techniques, the community should invest in a "floating facility" Lidar.
4) New Technology: Attention should be given to new technologies which will improve our Wind/temperature systems as well as daytime observations as a whole without losing sight of the science amongst all the toys.
5) New Horizons: Finally, the community should explore new lidar ideas such as the metastable He lidar as well as the $N_2^+$ 'Auroral' system.

In the technical session new observations and developments were presented by each of the CEDAR lidar groups. These fell in three main categories; technical development of new laser systems, development of new telescope systems, and sets of new observations. Developments in resonance lidar systems based on solid-state lasers into hybrid dye / solid-state systems (Na density/ wind/ temperature ) and completely solid-state systems (K density /temperature) were presented. Telescope designs and developments were presented that employ both mosaic systems and single large-aperture systems. New data sets were shown from both recent campaign observations and on-going measurements. The observations served to highlight particular events as well as issues of the general circulation.

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*Workshop Report:* **Upper Atmosphere Facilities/IS Radars**
*Convenor:* **D. T. Farley**

For the second year in a row the UAFs held a joint workshop, with an added short contribution on EISCAT. The aim was to describe what the facilities can and do measure, at both radar and optical frequencies, without much emphasis on the technical details of how the measurements are done. The capabilities were illustrated with examples of actual observations, but discussion of the scientific significance of these data was mostly deferred to other workshops or poster papers. There were about 60 attendees.

After a brief overview by Don Farley, there were presentations of 40-50 min each on Sondrestrom (J. Thayer, C. Heinselman and A. Gerrard with the latter giving an interesting student perspective of working in Greenland), Millstone Hill (J. Foster and P. Erickson), Arecibo (C. Tepley and M. Sulzer), Jicamarca (Farley), and EISCAT (T. Van Eyken). All the facilities seem to be in pretty good shape, in spite of ever increasing financial pressures, which will have to be faced squarely at some point. The continuing rapid increases in computing power and telescience capabilities mean that we can now look at data from all the observatories in nearly real time, and the data quality in some cases is improving as well. The major upgrade at Arecibo should soon have a positive impact on their data, the low power JULIA facility at Jicamarca has added enormously to the Jicamarca data output (an additional 3500 hours of non-IS radar data last year), and the new EISCAT radar on Svalbard is now operating and will soon be joined by a second radar funded by the Japanese.

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*Workshop Report:* **Wide Latitude Substorm (WLS) Study**
*Convenors:* **J. C. Foster, A. van Eyken**

A brief (1 hour) WLS working group meeting was held prior to the CEDAR/STORM Workshop. There were approximately 25 attendees. The 1997-1998 Wide-Latitude Substorm Studies campaigns made use of ISR World Days and were coordinated with UARC interactive campaigns. The April 1998 WLS interval was incorporated into a demonstration of UARC capabilities at NSF headquarters.

The use of WLS/UARC interactive features by the research community was discussed with the conclusion that the real-time features were of principal use to those coordinating and running the experimental campaign. It was decided to request an April-1999 WLS/ISR World Day campaign on fixed dates (no floating window) since substorm activity is now occurring regularly. The focus of the April 1999 campaign will be on detailed observations of individual substorms from distributed sites. In October 1999, WLS will combine with a Space Weather event campaign and will operate in the floating-window scheduling format, with the actual dates of the experiment chosen to match a best near-term prediction of major storm conditions. The experimental emphasis will be on storm phenomena as observed using wide-coverage experiments from distributed sites. Campaign operations will be scheduled based on the occurrence of appropriate solar disturbance and using the ACE and WIND upstream real-time solar-wind observations. Substorm and storm phenomenology observed during the April 1998 and April 1997 WLS campaigns were reviewed. The April 1997 event was covered in more detail during the STORM Workshop.

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*Workshop Report:* **CEDAR Storm Study**
*Convenor:* **M. J. Buonsanto**

A CEDAR Storm Study workshop was held at the CEDAR Meeting in Boulder on June 10, 1998. Total attendance was about 40. The following is a brief report on the presentations and discussions at the workshop. A more detailed report and the final agenda are available from the CEDAR Storm Study home page:

*http://www.haystack.mit.edu/css/*

The convenor began the CEDAR Storm Study workshop with a brief introduction. This was followed by presentations and discussion of specific projects and data sets related to the six storm intervals, three more general talks, and discussion of future plans.

1. *March 16-23, 1990 Storm Interval.* Matthias Forster reported on data taken by the Active satellite during overflights of Millstone Hill on March 21, 1990. These showed large concentrations of molecular ions above 700 km.

2. *June 5-14, 1991 Storm Interval.* John Foster described unique observations taken with a scan experiment at Millstone Hill on June 5. These showed coherent backscatter, strong convection velocities and enhancements in Te. Larisa Goncharenko described a large increase in the magnitude of the westward neutral wind seen in the lower thermosphere during this storm.

3. *November 3-11, 1993 National Space Weather Interval.* Delores Knipp provided an overview of progress in study of this interval, including a report on a special issue, which is soon to be published in JGR Space Physics. Barbara Emery described a study she has led which compares AMIE/TIEGCM results and observations. This work addresses the time lags in the response of the thermosphere to magnetic activity. Gary Bust described contour plots with tomographic reconstruction of the recurrent storms which occurred between August and December 1993. These showed deep electron density troughs and sharp horizontal gradients.

4. *May 1-5, 1995 Storm Interval.* John Foster described how a plot of the product Ne*Te (electron density*electron temperature) vs. latitude gives a rough indication of the variation of total energy as a function of latitude. Roger Smith described Fabry-Perot interferometer observations at South Pole station which showed elevated temperatures and winds.

5. *January 6-11, 1997 Storm Interval.* Gang Lu described her AMIE results for this storm interval; these have recently been published in JGR, and they have been used as input to runs of the TIEGCM. John Foster described coordinated Millstone Hill ISR and DMSP observations of the strong Te enhancement seen near 0800 UT on January 10. Phil Richards showed that neutral meridional winds derived from Ramey, PR ionosonde data were surprisingly similar to those seen on quiet days prior to the storm.

6. *April 10-11, 1997 Storm Interval.* Gang Lu presented her initial results from AMIE modeling of this storm. This was a typical storm period with minimum Dst ~ -80 nT. Josh Semeter presented optical tomographic results from the Boston University COTIF chain. Strong emissions were seen on the night of April 11 at 557.7 nm and 630.0 nm. Next followed three talks of more general interest. Mihail Codrescu discussed modeling challenges, data ingestion, and forecasting issues. The major problem for forecasting is that the high latitude forcings are not known well enough in advance, though ACE satellite observations of the IMF are of some use in this regard. Larisa Goncharenko discussed the need for observations of effects of magnetic storms in the lower thermosphere. The MLTCS program has now chosen effects of storms as a major new emphasis. Up to now, significant effects on lower thermospheric winds at middle latitudes have only been found under the most severe storm conditions. Doug Drob described the thermospheric response to the July 13, 1982 solar proton event as seen in DE-1 satellite FUV images and coordinated DE-2 in-situ data. The images allow one to infer integrated O/N2 column densities.

Next followed a quick review of progress on other projects related to the six CEDAR Storm Study intervals. Links to the updated project lists are found on the CEDAR Storm Study *Home Page: http://www.haystack.mit.edu/css/*

*Special Issue of JASTP.* Michael Buonsanto reported on the status of the special issue on Thermosphere/Ionosphere Storms, to be published in JASTP.

*Next CEDAR Storm Study meeting.* We decided to hold an informal (1.5-2 hr session) at the Fall 1998 AGU meeting to update progress on our storm projects. This session may be held in conjunction with a GEM workshop to be held just prior to or following the AGU meeting.

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*Workshop Title:* **Synthesizing Large-scale High-Latitude Ionospheric Electrodynamics**
*Convenor:* **A.D. Richmond**

The purpose of this workshop was to facilitate improved information exchange and coordination of efforts concerning the synthesis, specification, and empirical modeling of large-scale high-latitude ionospheric electrodynamics. There were 34 attendees.

The importance of being able to estimate the space-time variations of high latitude ionospheric convection, Joule heating, and auroral particle precipitation was reiterated: from a science perspective by Geoff Crowley, who summarized the discussions of the High Latitude Inputs workshop; and from an operational perspective by Terry Onsager, who described the needs of NOAA Space Environment Center customers. Operational requirements include: real-time operation at a sufficient cadence (~1 minute) to address problems associated with geomagnetically induce currents; gridded output, supplemented by easy-to-understand key parameters; and procedures that are drivable by real-time data, that have been validated not only as proof-of-principle but also under operational conditions, and that have good documentation. As described by Fred Rich, Delores Knipp, Ray Greenwald, John Holt, and others, the availability of useful data is continually improving, often in real-time or near-real-time: DMSP auroral particle fluxes, hemispheric power, equatorward auroral-oval boundary, ion drift velocities, and magnetic perturbations; digital ground magnetometers; SuperDARN and incoherent-scatter radar data; and auroral imagery. Increased community access and upgrades to synthesis procedures were described by Ray Greenwald, Gang Lu, and Art Richmond.

There was considerable discussion on the limitations of the synthesis procedures, particularly the importance of having accurate conductance information when trying to calculate currents from electric fields or electric fields from magnetic perturbation data. Although well-calibrated multispectral auroral imagery from space promises to contribute in a major way to resolving this problem, there remain questions about how accurately conductance's can be obtained from the images.

Plans are to continue the information exchange and coordination through an electronic mailing list (contact *richmond@ucar.edu* to receive mailings or to make submissions) and through future working group meetings.

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*Workshop Report:* **High Latitude Inputs**
*Convenors:* **G. Crowley and M. Codrescu**

The goal of the workshop was to identify missing important measurements needed to specify high latitude inputs to thermosphere and mesosphere.

Recent work has highlighted the importance of high latitude inputs for the mesosphere and lower thermosphere. These inputs include particle precipitation, joule heating and momentum forcing, which produce significant changes in the composition, chemistry, temperature and dynamics on both the local and global scales. The global magnitude, of these inputs and their distribution in local time, height, and geographic and geomagnetic location is not well understood. For detailed understanding, and ultimately modeling, of the thermosphere, ionosphere and mesosphere it is vital that we improve our knowledge of the high latitude inputs.

The speakers established the scientific importance of the high latitude inputs. In order to understand the measured thermospheric temperature, wind and compositional structure, the high latitude inputs driving the system need to be accurately known. The ionosphere cannot be accurately modeled without an accurate specification of the underlying neutral atmosphere, especially composition and winds. Measurement of the high latitude inputs is also necessary to understand magnetosphere/ionosphere coupling.

There are 5 key high latitude parameters needed to define the high latitude inputs. These are electric fields, electron density, electron and proton precipitation, and neutral winds. Height profiles of these parameters between 100-160 km are vital for defining the high latitude inputs. Despite great improvements in recent years, the high latitude inputs are all still seriously undersampled.

SuperDARN and the IS radars provide E-field maps for about half of the Northern Hemisphere, and 30% of the Southern Hemisphere high latitudes.
**RECOMMENDED**: More SuperDARN radars and a Polar Cap Observatory IS radar would be desirable to fill the gaps.

Knowledge of the high latitude electron density provides conductivities. Electron density profiles are provided by a few high latitude ionosondes and IS radars, but there are insufficient data to generate detailed electron density maps for estimating global conductivity's. The technique of ionospheric tomography using ground-based

receiver arrays for satellite beacon signals was described in detail. It inexpensively offers good spatial (vertical and horizontal) resolution over horizontal distances of 1000km on a routine basis.
**RECOMMENDED**: Deploy a tomography system near an IS radar site such as Sondrestrom, as a first step in assessing the utility of tomographic systems for global conductivity profile estimates.

Particle precipitation measurements are routinely available from various satellites, but these data are too sparse to accurately specify the global particle inputs to the atmosphere, and hence conductivities. Global conductivities have been determined from auroral imagers such as POLAR, but much more work still needs to be done in this area.
**RECOMMENDED**: Improve the image availability, reduction algorithms, and perform further validation.

E-region neutral winds in the auroral zone are very difficult to measure. This is a key problem for both the determination of high latitude inputs AND for determination of atmospheric response in the auroral zone. Are radars running in an appropriate mode occasionally making wind profile measurements up to about 125 km? Two kinds of optical systems are available: systems based on measurements of the auroral airglow, or ones based on the background airglow. Systems measuring the background airglow are compromised by auroral events, while systems designed to measure the auroral airglow are not able to determine the height of the emission, so cannot get wind profiles. These problems are inherent in both ground-based and space-based instruments.
**CHALLENGE**: Design a technique for routinely measuring accurate neutral wind profiles in the auroral zone at heights between 100-160 km.

The AMIE technique is able to assimilate many of the electrodynamic data sets to obtain estimates of various high latitude inputs, including potential patterns, conductivities and currents. This is one of the most useful tools available to the community, but it could be upgraded to significantly improve its performance and usefulness in several areas (see Richmond Electrosynthesis workshop).
**RECOMMENDED**: Improve electrodynamic assimilation techniques.

To quantify the global neutral atmospheric response to the high latitude inputs is not straightforward. The data sets include measurements of temperature and winds by FPIs and IS radars, but all are sparse. By far the most numerous measurements are of ionospheric electron density profiles, including IS radars and ionosondes. The ionospheric response depends on the compositional response, but there is no easy way to measure the global composition.
**RECOMMENDED**: Find ways to measure global compositional response.

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*Workshop Report:* **High Latitude Plasma Structures (HLPS)**
*Convenor:* **J. Sojka, E. Weber**

A HLPS mini-workshop was held in Boulder, Colorado, on Friday, June 12, with a group of about 25 students and scientists. The meeting began with a summary of the January 1998, HLPS campaign given by Cesar Valladares. This campaign was centered around noon in the Scandinavian sector utilizing the Scandinavian ISRs along with the Sondrestrom ISR in a search for patch formation mechanisms other than the most recently studied mechanism whereby a changing IMF by chops up the TOI to form patches. Roger Smith pointed out that optical data was also available from Svalbard during this campaign period. Cesar followed up this campaign discussion with a comparison of four patch formation mechanisms and lead into a discussion of the proposed January, 1999, HLPS Campaign. This is to be held on January 19, 1999, B1 3 days. The HLPS community hereby announces this campaign and requests information on instruments that will be running during this period. Please contact Cesar Valladares with your input.

Parvez Guzdar described the recent results from his Gradient Drift Instability (GDI) modeling in 3-D. In the present form of the simulations, the 3-D code generates 2-D "finger" irregularities of delta n/n amplitude at about 100%. Parvez suggested that a Kelvin-Helmholtz instability would probably act along the "finger" structures to break them up into smaller scale irregularities. The fingers developed over a 4-hour time period. Jan Sojka suggested that the electric field would not remain fixed for 4 hours and that by introducing more realistic time variations of the electric field orientation into the simulations, the fingers would be prevented from forming.

Lie Zhu discussed the observation of traveling convection vortices (TCV) from the Antarctic by the AGO magnetometers. He also showed a possible example of a conjugate pair of TCVs. This lead into a discussion on the need to have involvement of "data analysis" scientists from the AGO and other Northern Hemisphere magnetometer chains to verify the conjugacy aspects of the TCV. Indeed, the need to rejuvenate a focussed

campaign with more extended participation on such issues was raised. Another area in which greater participation was needed was the need to carry out a detailed observational study of what degree of plasma density structuring and irregularity formation is associated with a polar cap sun-aligned arc. Although significant progress has been made on sun-aligned arc electrodynamics, the density irregularity aspect is still relatively undocumented.

Jan Sojka ended the workshop with a brief status report on a TDIM model-DE-2 patch calibration study that has been started with Rod Heelis. The calibration work is expected to yield a better understanding of how similar, or otherwise, model patch definitions and satellite observational patch definitions are. A brief discussion was held on whether or not the HLPS/SRAMP-GAPS community is ready for a 1999 Peaceful Valley meeting. The group reiterated that the workshop format for such a meeting should have well defined research topics and encourage discussion rather than AGU-type presentations. To determine the readiness, a questionnaire will be distributed among the HLPS-GAPS scientists.

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*Workshop Report:* **Global Ionospheric Forecasting Techniques (GIFT)**
*Convenors:* **T. Fuller-Rowell, D. Anderson, and J. Sojka**

A two hour workshop entitled "Global Ionospheric Forecasting Techniques" (GIFT) was held at the CEDAR meeting in June. This workshop originated at last year's CEDAR meeting as SWIFT (Space Weather Ionospheric Forecast Techniques) but because of an ACRONYM conflict was changed to GIFT. It was convened by Tim Fuller-Rowell, Dave Anderson and Jan Sojka and was a highly successful, but abbreviated (only 2 hours), workshop with 53 attendees. As a result of last year's workshop, three specific areas of interest have been identified:

1.) to determine the degree and sources of variability of the midlatitude ionosphere so that we understand the baseline on which storm-time changes are imposed;

2.) to determine if measurements made at an earlier local time or another latitude/longitude can provide a useful forecast for the equatorial ionosphere and

3.) to determine the temporal and spatial coherence scales in the various regions of the ionosphere, which have implications for both observation requirements and model resolution. At this year's GIFT workshop only the first two items were discussed.

Tim Fuller-Rowell moderated the midlatitude topic discussions that included presentations by Phil Richards, Mike Mendillo, Devin Della-Rose, Rodney Viereck, Tim Fuller-Rowell and Frank Marcos. A number of lively discussions ensued associated with each of these presentations and many focussed on the best way to identify this variability and how to assign sources to it. The question of how to adjust model inputs, holding others constant, was a theme, which kept recurring. Covering the low latitude topic, Dave Anderson was moderator and presented examples of how unique sensors at unique locations could be used to infer the vertical ExB drift, which is the most important transport mechanism in the equatorial region. Roland Tsunoda described the WestPac campaigns, which involve a network of ground-based radars and magnetometers in the Pacific region to study the formation of the equatorial anomaly and the onset conditions for equatorial spread-F after sunset. Finally, Chris Rocken gave a presentation on the proposed US-Taiwan bilateral COSMIC program (Constellation Observing System for Meteorology, Ionosphere and Climate). This is a constellation of eight, low earth orbiting satellites using GPS/MET type sensors to measure both tropospheric as well as ionospheric profiles using the limb sounding techniques. Such a constellation would provide over 4000 occulations a day, globally, and with such a database, the opportunity to develop realistic global ionospheric data assimilation forecast models becomes a reality. We wish to thank all of the participants and attendees and look forward to an even more enthusiastic workshop next year.

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*Workshop Report:* **CEDAR-METRICS**
*Convenor:* **T. Fuller-Rowell**

A 2-hour workshop on METRICS for the Ionosphere and Thermosphere Domain was held at the CEDAR Meeting, and was attended by about 25 people. The main purpose of the meeting was to present the activities of a panel that has been preparing a document to establish metrics for the National Space Weather Program in the ionosphere-thermosphere (I-T) domain. A draft of the document was distributed at the workshop and during the CEDAR meeting. The document and presentation were designed to solicit feedback on the activity, so that following some initial community response the document could be posted on the web for wider dissemination. This is still planned for early September, and will include both the I-T and the magnetosphere-ionosphere sections of the document. The goal of the METRICS Document is to develop a framework whereby a quantitative measure of the success of the NSWP can be established. Through "metrics" we will be able to determine where we are today in prediction capabilities, and define where we would like to be in 3, 5, or 10 years time.

The Workshop covered the following topics:

1. Brief history and purpose of metrics.
2. Definition of a "metric".
3. A discussion of measurement accuracies and why they are important.
4. A discussion of current model prediction accuracies.
5. Suggestions for metrics for the ionosphere-thermosphere domain.

Following and during the presentation some lively discussion and interaction ensued, which were of great benefit. From this initial feedback, and subsequent comments received since the workshop, it was evident that the framework of the document needed revision to make the purpose of the activity clearer. In this respect the workshop achieved its objective.

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*Workshop Report:* **CEDAR/GEM Perspectives on Models for the New Millennium**
*Convenors:* **M. Hagan, R. Wolf**

This two-part workshop series convened by Maura Hagan and Richard Wolf was held during the CEDAR and GEM meetings and drew about 60 and 45 participants, respectively. The workshop goals to identify the challenges anticipated in the further development of large-scale numerical models and to plan for a follow-on Chapman conference focused on these issues were achieved. The sessions included invited overviews of the relevant issues facing magnetosphere, ionosphere, thermosphere, and middle atmosphere modellers by John Lyon, Art Richmond, Kevin Hamilton (CEDAR), Tim Fuller-Rowell, Bob Schunk, and Jimmy Raeder (GEM). These presentations motivated lively workshop discussion on scientific objectives, techniques to couple models, parameterizarion of sub-grid-scale effects, nested grids, observational constraints on models, data assimilation, and the parallelization of existing code. The community consensus was to build on the momentum of these workshops and to propose that a Chapman Conference be held in late 1999. To help achieve the former Jimmy Raeder and Maura Hagan are convening a joint SM/SA special session on Models for the New Millennium at the 1998 Fall AGU Meeting.

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*Workshop Report:* **High-Latitude E-region Dynamics, Energetics and Processes: Rocket at Sondrestrom?**

*Convenor:* **J.P. Thayer**

The purpose of this workshop was to initiate discussion concerning key issues related to high latitude E-region dynamics, energetics and processes and to plan a possible rocket campaign near the Sondrestrom incoherent scatter facility in Greenland to resolve some of the outstanding problems in this field. There were about 40 attendees.

The workshop was designed around brief science presentations summarizing the issues and discussing possible ways of resolving the problems through means of ground-based measurements, rockets and satellites. In starting the session, three important questions were put forth to the audience: Given the potential for a possible rocket campaign to address numerous scientific issues, what is the central scientific theme?, why Greenland?, and what is the timeline? The preliminary answers to these questions are given below.

**What is the Scientific Theme?**

A central theme is important in establishing a focused campaign. The most common theme from the workshop addressed understanding the height-resolved electrodynamics at high latitudes involving measurements of neutral winds, conductivities, ion and neutral composition and temperature, currents, Joule heating rates, etc. This theme relates directly to other initiatives within NSF and NASA such as the NSF CEDAR program, the NASA TIMED program, the planned NASA GED program, and the collaborative TIMED/CEDAR program, specifically the ion/neutral coupling subgroup. Although the proposed central theme provides focus, it does not exclude other possible experiments that may benefit by such an arrangement of rocket payloads, ground-based instrumentation, and satellite coverage nor the possibility of revisions to the theme as discussions progress. Feedback on this theme or other possible experiments would be appreciated and can be conveyed through email to *thayer@sri.com*. Below lists the central theme and a number of possible subtopics discussed at the CEDAR meeting.

Central Theme:

*Height-resolved electrodynamics*: Joule heating rates; Current density; Conductivity; Neutral winds

Subtopics:

*NLC / PMSE Processes:* Dust; Gravity wave activity; Temperature

*Thin Layers - Ions and Neutrals*: Ion composition; E-field; Minor and major neutral constituents

*Lower E-region Instability Processes*: Electron temperature; E-field; Neutral winds

*Auroral HF Roar Processes*: E-M wave fields; Electron density structure

*Cusp Processes; Poynting Flux; Small-scale gravity waves*

**Why Greenland?**

- The rocket dispersion zone is better than in most arctic rocket sites with the possibilities of launching to the North, East, or South providing polar cap or auroral zone measurements.
- The incoherent-scatter radar facility has improved in its capabilities through improved radar pulse schemes, new instrumentation (such as Rayleigh/Mie/Resonance lidars, meteor scatter radar, UV spectrograph, etc.), and improved infrastructure. These capabilities can better complement rocket measurements.
- The facility is located only about 13 km from the rocket range and is readily available for supporting logistics and operations.
- The Kangerlussuaq International Science Support, KISS, facility in town is fully supportive of scientific studies and can provide the necessary accommodations for lodging, meetings, and storage.

**What is the Timeline?**

- Target Launch date => Late summer 2002
- Campaign Initiation => CEDAR Workshop June 1998
- Proposal Workshop => SRI December 1998
- Proposal Submission => August 1999
- First Funds => January 2000

*Workshop Report:* **Topside Ionosphere**
*Convenors:* **P. Erickson, S. Gonzalez, R. Kerr**

The topside workshop was convened to highlight current projects and plan future efforts dealing with light ions and neutral species in the topside ionosphere and exosphere. Despite being scheduled on a Friday afternoon (and opposite the World Day scheduling meeting!), we had very good attendance (25 people) and useful discussions.

Several presentations highlighted various aspects of current topside ionosphere research. Mike Sulzer from Arecibo presented a small tutorial on the effects of electron collisions on incoherent scatter (IS) spectra, and in particular discussed their relevance to the correct analysis of Jicamarca topside (and F region) IS spectra taken at angles close to perpendicularity with the magnetic field. Bryan MacPherson, also from Arecibo, discussed insights into topside energetics and photoelectron heating provided by data acquired during a recent eclipse, and modeled using the Sheffield University Plasmasphere-Ionosphere Model (SUPIM). Phil Erickson moved the discussion of comparisons between data and models to higher latitudes by presenting a detailed comparison between Millstone Hill results and predictions by the Field-Line Interhemispheric Plasma (FLIP) model constructed by Phil Richards. Millstone observations are in reasonable agreement with FLIP provided He+ is omitted from the model in the near topside below 700 km, with an observed descent of H+ after midnight driven by a cooling plasmasphere.

After an update on topside optical plans by Bob Kerr's group (presented by John Noto), Susan Nossal gave a status report on the Wisconsin H-Alpha Mapper (WHAM) project, which produces measurements of the geocoronal neutral hydrogen population through observing H-alpha emissions. She also initiated a discussion on the possibility of a future meeting specifically focussed on exploring ways to enhance observational coverage of the exosphere simultaneous with radar observational campaigns. These measurements are critically important for any topside observational campaign since neutral exosphere species (H, He, and O) are chemically coupled to the ionized population. Additionally, work at Arecibo has shown that the MSIS model, the most widely used neutral exosphere proxy in modeling work, does not always agree with data, particularly in the case of neutral hydrogen response to storm conditions.

The final phase of the workshop was spent planning future analysis projects. A general discussion led to the consensus that a more in-depth, focussed workshop is needed to coordinate analysis of past and future topside data sets, particularly those resulting from the Plasmaspheric Observations of Light Ions in the Topside and Exosphere (POLITE) world day campaign. We identified two possible workshops, one on topside ionospheric measurements, and the other (mentioned above) on issues relating to ground-based optical remote sensing of the exosphere. Sixto Gonzalez and Phil Erickson agreed to explore the planning of a topside ionosphere workshop in the fall of 1998, perhaps hosted at Arecibo. Susan Nossal and Phil Erickson will separately explore planning of the exosphere measurement workshop.

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*Workshop Report:* **Lower Thermosphere Coupling Study (LTCS)**
*Convenors:* **C. G. Fesen and R. M. Johnson**

The LTCS workshop enjoyed a large turnout, with over 50 people in attendance. To date, LTCS has conducted 17 campaigns and the workshop was devoted to deciding on projects to be pursued. Three general areas for group activity emerged which are described below.

All groups will report on their progress at an evening meeting planned for the Fall 1998 AGU meeting. Anyone interested in participating in any of these studies is welcome and urged to contact the coordinators named below or the LTCS organizers. For more details, email addresses, and information on LTCS and the campaigns, check the webpage at *http://www.dartmouth.edu/~cfesen/ltcs*

1. TIMED/CEDAR collaborative studies - *Coordinator: D. Drob, NRL*

The group briefly discussed issues of assimilation of ground-based and TIMED satellite data for collaborative studies of tides, waves, etc. Jeff Forbes' group is currently developing necessary software for this work. To prepare for TIMED/CEDAR collaborations, the group proposed a detailed study of LTCS 11 as a test bed of combined ground-based and satellite datasets, with focus on the lower thermosphere. Datasets include those from the incoherent scatter, MLT, and meteor radars and the UARS satellite.

2. Geomagnetic activity

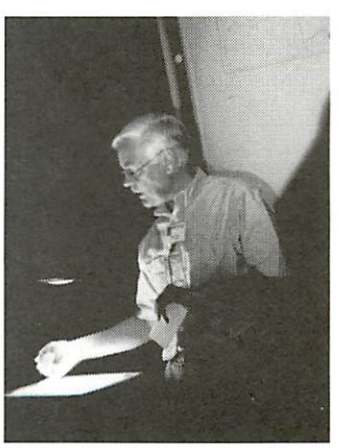
To examine the effects of geomagnetic activity on the lower thermosphere manifested in LTCS datasets, the group plans two projects:

a) Analysis of existing campaign data - *Coordinator: I. Azeem, U. Michigan.*

The objective is to analyze existing campaigns that occurred during periods of significant geomagnetic activity (Kp>4). In the case of radar data sets, most have already been analyzed and can reasonably easily be re-binned for this study. This effort will provide useful information for a detailed look at LTCS 11 (see above) and future work with TIMED data. The project will entail analysis of the Sondrestrom, EISCAT, Millstone Hill, Durham, and Arecibo datasets and theoretical modeling with the NCAR TIEGCM.

b) Observations in response to geomagnetic storm alert - *Coordinator: J. Salah, MIT*

The purpose of this effort is to organize the UAF and other instruments to respond to an alert for a high level geomagnetic storm (Kp > 6), and collect temperature and wind data in the lower thermosphere (80-150 km). An observing window will be defined for March 1999, and a four-day data collection interval will be exercised within that window if a severe storm takes place. The successful WLS mechanism instituted at Millstone Hill will be used to monitor storm conditions and alert participants. This effort is considered as a pilot project for TIMED/CEDAR collaboration as a Joint Observation of the Effects of Storms (JOES) in the lower thermosphere. A white paper will be prepared in time for the get-together at the Fall AGU meeting to describe the effort, and will be circulated to interested persons who may contribute.



3. Climatologies - *Coordinator: C. Fesen, U. Texas, Dallas.*

This effort is to analyze existing LTCS datasets for seasonal and solar cycle effects, providing the climatological background necessary before undertaking studies of variability.

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*Workshop Report:* **MISETA**
*Convenor:* **J. Meriwether, C. Fesen**

The MISETA (Multi-instrumented Studies of Equatorial Aeronomy) group hosted a two-hour CEDAR workshop to review progress made since the winter workshop that was held at Clemson in January 1998. The attendance was excellent with nearly all seats in the lecture hall occupied. About 25 students were present in addition to about 40 scientists. As promised, hats bearing the MISETA logo were distributed to all. The MISETA program has been funded to continue operations through solar maximum in 2001.

The MISETA principal investigators and students reviewed the new results achieved in MISETA modelling and heard summaries of the highlights from recent analysis of observations obtained with the MISETA instruments at Ancon and Arequipa, Peru, as well as the instruments located elsewhere (Tucumann, Jicamarca). The reviews began with Cassandra Fesen who discussed the recent results of her NCAR TIEGCM modelling of the solar minimum equatorial thermosphere. Recent measurements of the nighttime ionization profile in the E-region indicate that the equatorial E-region plasma content is considerably below what previous NCAR model calculations had deduced. Reducing the model E-region plasma concentrations to levels considerably below 1000 ions/cm$^3$ reduced the dissipation rate while allowing the semi-diurnal tidal mode to penetrate higher into the F-region thereby increasing the amplitude of the midnight temperature maximum. This modification of the E-region plasma content also had the effect of changing the modelled pre-reversal enhancement to more closely reproduce the observed behavior of a significant increase in the vertical upward plasma drift just after evening twilight. Also significant was that the inclusion of such tidal modes delayed the reversal of zonal winds from west to east in the evening hours. Cassandra also discussed plans for improving the presentation of MISETA results for the MISETA WEB page. She will provide instructions for the production of GIF files using IDL code so that each participant can submit campaign results to the MISETA Webmaster for posting on the Web page. It is intended that MISETA results will be routinely made available in this way.

Cesar Valladares summarized the analysis of Ancon scintillation drift measurements as combined with the Arequipa FPI observations. The indication is rather strong that when weak zonal thermosphere winds exist in the early evening, the probability for the development of spread-F and scintillations will be higher than for the case of strong winds (speeds greater than 50 m/s), which is consistent with the result summarized by Fesen. A draft of a JGR paper summarizing these results will be prepared this summer with submission planned for this fall.

John Meriwether using information provided by Rick Niciejewski summarized the status of the Michigan Fabry-Perot interferometer that is located at Carmen Altos. This instrument is currently not operational but a substantial amount of usable data was acquired during the August-September 1997 period that overlaps with simultaneous measurements from MISETA instruments. Meriwether also pointed out an interesting aspect of the Arequipa FPI results for this same time period in which there is seen a momentary reduction of the zonal wind shortly before the "brightness wave" (BW) passes through from South to North. He suggested that this zonal wind reduction was caused by the "back pressure" of the midnight pressure bulge that is associated with the BW events.

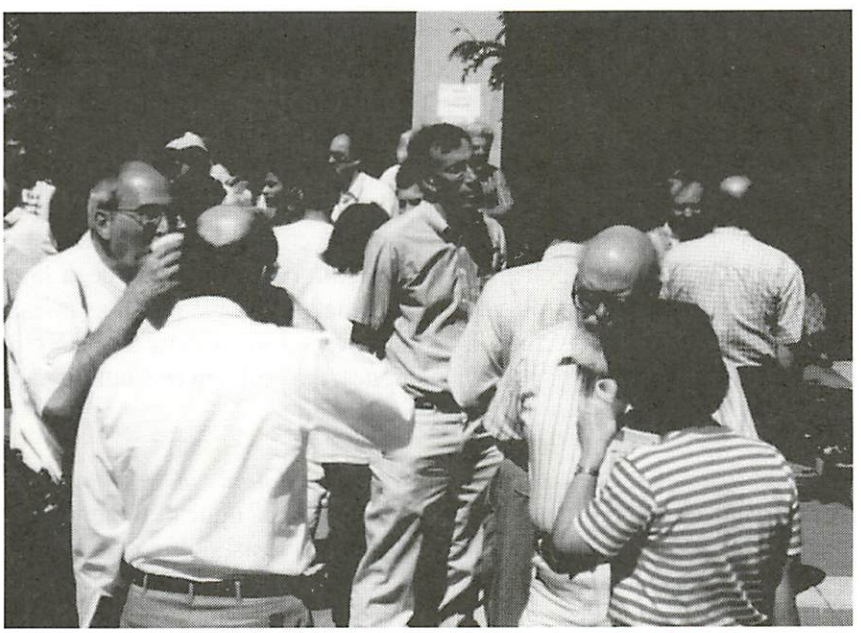
Michael Mendillo and his students summarized their analysis of all sky images from Arequipa and Tucumann. Their aim will be to deduce the drift speeds of airglow depletion events for both sites to determine whether the zonal winds are weaker for the higher latitude station. Theory suggests that this would be true as increased ion drag caused by the enhanced electron densities within the Appleton Anomaly regions should result in a reduction of the neutral wind speed. They have also continued their analysis of BW events for both stations.

David Hysell reviewed the continuing series of Faraday temperature observations obtained at Jicamarca with the incoherent scatter radar. The results are looking very reasonable with very good error bars. The measurements can be downloaded from his Web page, *http://landau.phys.clemson.edu/faraday* or by clicking a link from the MISETA Web page:
*http://www.dartmouth.edu/~cfesen/miseta/miseta.html*

Plans were discussed for a major MISETA campaign in April, 1999 to support the Terrier satellite that is due to be launched this fall. Another MISETA workshop is scheduled to be held at Clemson this coming winter.

*Workshop Report:* **Turbulent upwellings: Effects of Magnetic Activity in the American Sector**
*Convenors:* **M. C. Kelley, E. Kudeki, W. Swartz**

Movies of the allsky images obtained during November 22/23, 1997 and February 17/18 1998 were shown and discussed at this workshop which was attended by 25 researchers. Likewise, coherent scatter data at 50 MHz were presented, as were incoherent scatter data at 430 MHz. Both turbulence (3m) and uplifts were co-located with airglow depletions. One hypothesis for the bright regions inolves poleward transport of anomaly plasma. S. Gonzales suggested the dayside as another possible source quoting some results from GPS maps. J. Foster discussed the importance of the magnetic anomaly in this sector which was supported by DMSP observations for the events in the sense that the American sector seems uniquely responsive to the high Kp. Plans were made to write a series of papers with exchange of drafts sometime this fall.



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*Workshop Report:* **Eddy Transport and Energetics in the Mesosphere and Lower Thermosphere.**
*Convenor:* **S. Makhlouf**

The workshop was attended by 65 researchers, and seven speakers made presentations. The workshop was designed to provoke a wide range of discussion on the studies of turbulence and gravity waves in the Mesosphere and Lower Thermosphere (MLT). One particular interest in this workshop was to discuss approaches and needs for experimentalists and modelers to try to answer some of the important open questions regarding the energetics of the MLT region.

The responses to an email sent by the convenor to all the attendees of the EDDY workshop soliciting input on this particular workshop were very positive, and there was general support for this type of workshop which emphasized theory and modeling as an important component of the CEDAR program and as a complement to the campaign-oriented workshops which tend to dominate the CEDAR meeting. The speakers did an excellent job in highlighting the basic science and the important topics and open questions that need to be addressed for improving our chemical and dynamical models.

The plans for the future are to have a continuation for this workshop to explore ways to study outstanding problems regarding diffusion, variability and dynamics of the MLT region, and to explore possible connections to local and international campaigns like PSMOS and others.

*Workshop Report*: **Tomographic Studies of Upper Atmospheric Phenomena**
*Convenors*: **J. Semeter, G. Bust, F. Kamalabadi**

The first CEDAR tomography workshop was held on Monday June 8, 1998, with 70 people in attendance. This workshop provided a forum for the application of tomography to remote sensing of the upper atmosphere, a topic that has been pursued independently by many scientists in the CEDAR community over the past decade. Tomography describes the mathematical process by which density distributions (such as photon volume emission rate, or ionospheric electron density) are estimated from integral measurements (such as total electron content or photometric brightness). The promise of routinely and inexpensively imaging volumetric distributions from standard multi-location data sets makes tomography a seductive topic, both as a means of linking observations and modeling and as a discovery tool. The purpose of this first-time workshop was: (1) To expose the CEDAR community to the various ways in which tomography is being applied in upper atmospheric research, (2) To foster collaboration between researchers grappling with similar technical, mathematical, and scientific issues, (3) To define specific scientific objectives, and (4) To discuss future collaborations.

Formal presentations were organized by the nature of the tomographic measurement into 3 broad categories: satellite radio beacon, ground-based optical, and satellite EUV. The introductory talk by Joshua Semeter described the basic mathematical framework for algebraic tomography, demonstrating the concepts of ill-conditioning and solution non-uniqueness. Gary Bust then introduced Computerized Ionospheric Tomography (CIT) and together with David Coco presented results from the 1997-98 Caribbean campaign. Len Kersley and Simon Berry presented reconstructions from their Scandinavian receiver chain, showing ionospheric signatures of magnetospheric reconnection. Joshua Semeter then introduced the subject of ground-based Atmospheric Emission Tomography (AET), motivating the use of physical models in regularizing this problem. Dirk Lummerzheim described uncertainties to be considered when using optical tomography to infer auroral energetics, and Rick Doe linked these discussions by presenting an algorithm for recovering incident electron spectra by means of a vertical "eigenprofile" decomposition. Finally, Gary Swenson presented an example of auroral tomography where horizontal instead of vertical regularization was justified. Farzad Kamalabadi then introduced EUV ionospheric remote sensing and summarized the TERRIERS space-based tomography mission. Andrew Stephan showed a simulation of tomographic imaging of an equatorial plasma instability using TERRIERS instrumentation. Finally, Stefan Thonnard reviewed the upcoming ARGOS mission, describing an approach for tomography of limb-scan EUV measurements using discrete inverse theory.

At this point, a list of proposed discussion topics was displayed, and the meeting was continued in small groups that formed naturally around these topics. Some of the major results from this highly successful format are as follows:

1. *Algorithms*: Parametric regularization algorithms developed from discrete inverse theory have been used extensively in visible and UV tomography, but have not been widely pursued in CIT. The value of this approach for CIT will be evaluated.

2. *Error analysis*: Quantitative analysis of solution confidence in nonlinear tomography algorithms is not straightforward, and has been largely treated by qualitative arguments. As we progress towards using tomography as a discovery tool and as a means of resolving open science issues, the problem of solution variability must be rigorously addressed.

3. *Assimilation of Existing data*: A large body of serendipitous optical tomographic data exists due to the extensive existing network of overlapping wide-field cameras at polar latitudes. An effort will begin to evaluate and assimilate the potential of these data for tomographic studies.

4. *New scientific applications*: Due to its passive nature, AET can be used as a routine diagnostic to aid other experiments. For example, the altitude of 557.7nm emission can provide useful contextual information for FPI wind measurements, and tomographic imaging of the diffuse aurora can be used to aid in distinguishing between coherent returns and precipitation events in ISR data. Both CIT and AET are now being used as discovery "metainstruments", capable of addressing issues in magnetosphere-ionosphere reconnection and atmospheric photochemistry.

5. *Campaigns and proposals*: One focal point for combined radio, visible, and EUV tomography is the upcoming TERRIERS mission. The results of such collaborative efforts will be valuable for global space-weather modeling, and plans for joint proposals are being discussed. Also discussed was the possibility of supplementing the Sondrestrom optical facilities for use as a comprehensive test site for using tomography to estimate particle energetics and E-region conductivities. For more information on the CEDAR tomography workshop with related links *http://vega.bu.edu/~jls/tomography*

*Workshop report:* **Mesoscale Spatial Structure in the Thermosphere: Observations and Modeling**
*Convenors:* **M. Conde and W. Wang**

This was a "special topics" workshop, focused on the occurrence and possible large-scale consequences of thermospheric spatial structure at small and "meso" spatial scales. There were approximately 30 attendees. Most of the 2 hour period was occupied by individual presentations. These were:

*M. Conde* - gave a general introduction, including examples of many historical observations that indicate the existence of small-scale structure in the thermosphere. Recent imaging Fabry-Perot spectrometer observations from Poker Flat were also presented, showing associations between the aurora and spatial structure in F-region horizontal wind fields.

*W. Wang* - presented recent results from the high spatial-resolution "TING" model of the thermosphere. These results showed that various model fields were significantly modified over global scales, both by increasing the model's spatial resolution and by driving it with high-resolution auroral precipitation observations. Once the model resolved small-scale processes, it showed that these have a global-scale impact.

*M. Codrescu* - showed the effects of small-scale variability in the convection electric field. Comparison was made between model runs using a simple empirical electric field model, and runs where a randomly chosen "noise" component was added to this field. Again, large-scale differences were seen, particularly in Joule heating.

*J. Meriwether* - presented 630-nm Fabry-Perot observations of thermospheric neutral wind and temperature gradients above Arequipa, Peru. Viscous dissipation of waves generated by orographic forcing in the Andes was suggested as an explanation for the localized gradients. J. Schoendorf - presented NCAR-TIGCM simulations showing mesoscale cellular structures in the high latitude neutral density at altitudes from 120-350 km. It was suggested that the density cells result from the dynamic meteorology of thermosphere-ionosphere coupling.

*R. Clark* - presented meteor and incoherent scatter radar wind measurements from Durham and Millstone Hill, respectively. Both instruments showed that for altitudes between 100 and 120 km, the spatial variability of the wind was often several times as great as the mean wind, even down to spatial scales as small as seven kilometers.

*R. Smith* - gave two presentations. First, lidar observations from Poker Flat were presented on behalf of R. Collins. These showed thin and sporadic sodium layers above 100 km altitude. Second, the plans and scientific rationale were presented for a campaign of wind and temperature observations using an array of five different Fabry-Perot spectrometers to be deployed across Alaska. Observations will commence in the 1998/99 winter. Particular emphasis will be placed on spatial variations of the vertical wind.

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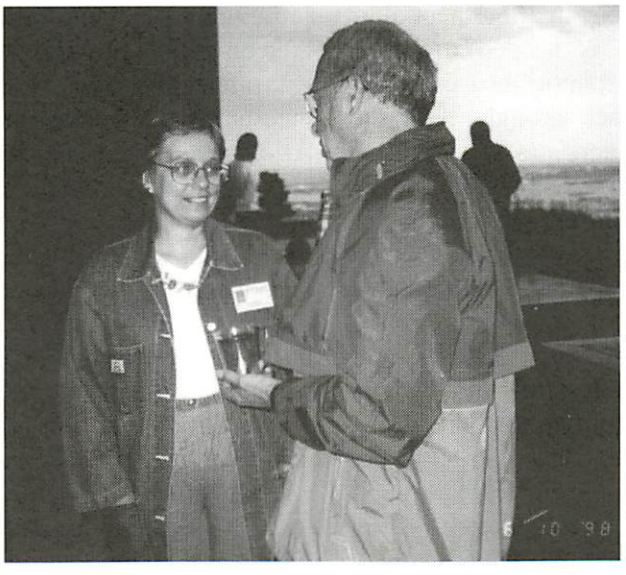

*Workshop Report:* **Impact of Meteoric Material on the Terrestrial Atmosphere**
*Convenors:* **W. D. Pesnell and J. Grebowsky**

Meteors constantly bombard the Earth, supplying easily ionized material to the E-region. Research at CEDAR is often concentrates on the consequences of the meteoric input but not the meteoroids themselves. The goals of this workshop were to introduce some of the effects of the meteoroids striking the Earth's atmosphere. As a first-time workshop we concentrated on covering the techniques used to see meteors, their remnants in the atmosphere, and the inter-planetary dust that produces them. Each of the speakers gave a review of their topic and entertained questions. The 55 attendees asked many questions and brought up new points to be considered. Meteors and meteorites have been studied for 300 years but, judging by the large number and low overturn of attendees, it is still an exciting area of research.

A brief review of meteors and how they are ablated by the atmosphere was given by Dean Pesnell. He discussed how the friction encountered by a meteoroid as it enters the atmosphere heats the meteoroid and causes it to evaporate. The evaporated material is ionized by its impact with the atmosphere, causing a meteor trail to appear in both visual and radar observations. Meteors with larger velocities leave a brighter, longer-lasting trail. Leonid meteoroids have the largest entry velocity of any recurring stream and their large flux in 1999 and 2000 has fueled much of the renewed interest in meteor research.

While the remnant becomes dust, the evaporated material becomes another minor gas. Chemical reactions determine which metallic compounds were produced from the meteor. At low altitudes, the metals move into molecular compounds and are of little interest to ionospheric physicists. Between altitudes 90 to 120 km the metallic species are atomic and can exist in either neutral or ionized states. Laboratory research is needed to better quantify the reaction rates and atmospheric measurements are needed of minor gases that react strongly with the metallic atoms. It is important to understand the origin of meteoric material. Mihaly Horanyi from the University of Colorado gave an excellent summary of the observations of inter-planetary dust that become micro-meteorites when they enter the Earth's atmosphere. Several satellites have carried dust detectors around the solar system probing the dust content as a function of heliocentric distance and latitude. The sensitivity characteristics of the various detectors leads to some ambiguity in the dust measurements. However, several statements can be made. The mass-flux distribution of micro-meteorites follows a power law in the cumulative flux measurements. It is difficult to establish the velocity of the inter-planetary dust, but there are several classes of objects. For example, material from the asteroid Belt is near the ecliptic and moves in the same direction as the planets. Further research is needed into the various populations of meteoroids including their velocity distributions, orbital inclinations, and whether they come from our solar system, the surrounding Oort cloud, or even inter-stellar space.

Our first example of radar observations was the meteor radar run by Ron Clark (University of New Hampshire). He uses the constant rain of extra-terrestrial material to probe the winds in the upper mesosphere. The lifetime of the ionized material is long enough to give reproducible measurements of these winds. Combining his results with incoherent scatter radar measurements from Millstone Hill gives winds from 90 to 300 or more kilometer altitude. Dr. Pesnell then gave a brief review to the VHF measurements of incoming meteoroids at the Arecibo radar. These measurements apparently see the head of the meteor as it moves through the atmosphere - not the long trail of ionized material left by the meteor. From the discussion it is apparent that the head echo problem is not yet resolved.

Next, Tim Kane (Pennsylvania State University) showed how individual meteors produce signals in resonance lidar measurements. He is measuring the newly deposited material from an incoming meteoroid as the background winds of the atmosphere move the trail across his beam. The altitude distribution of observed lidar meteor events agrees roughly with that of the measured sodium and iron atomic layers. The recommendation is to use short integration times, saving the profile from each laser pulse. You can add profiles to increase the signal to noise ratio, mimicking a longer time integration, but preserving the possibility of observing the individual meteors. Continuing to examine the variety of available measurements, Joe Grebowsky spoke about satellite measurements of minor metallic ions from the AE-E and AE-C satellites and the Space Shuttle. He noted that there are distributions in latitude and local solar time that can be mostly explained by fountain models but many details remain unexplained. James Clemmons gave a short introduction to his innovative mass spectrometer that has the time resolution required to explore the entire range of material thrown off by an incoming meteoroid. Time resolution leads to altitude resolution as a sounding rocket moves through the ion layers. Measurements taken in the past have had limited spatial resolution or concentrated on a few metallic ions as they needed to scan in mass for each ion they wished to measure. The rotating electric field of Clemmons' instrument projects masses from a large range onto a position-sensitive detector that records the entirety of the available mass range.

*Workshop Report:* **Accessing the CEDAR DataBase**
*Convenors:* **R. Barnes (SCD/NCAR) and P. Kellogg (HAO/NCAR)**

Hands-on sessions were scheduled for June 8, 10, 11 and 12, for those interested in trying the present interactive access utility cmenu led by Roy Barnes and demonstrations by Patrick Kellogg of the future CEDAR Data Base web access. During the meeting about 18 people attended one of four afternoon workshops. Six workstations were available at which individual instruction was provided. Handouts described how to start exploring capabilities independently, but usually the interactive access utility (cmenu) was demonstrated. The cmenu utility produces a summary of available data for campaigns or instruments of interest and sample data subsets were obtained in the new flat file output option. Model outputs and empirical models are also available through cmenu. Caveats and nuances of data organization were discussed. Five requested logins to further pursue independent data access. Most stayed about an hour, spending about 40 minutes being helped through cmenu by Roy Barnes or Patrick Kellogg, followed by about 10 minutes devoted to future web access presented by Patrick, and finishing by trying things out on their own. Most who came were students, but about a quarter or a third were non-students.

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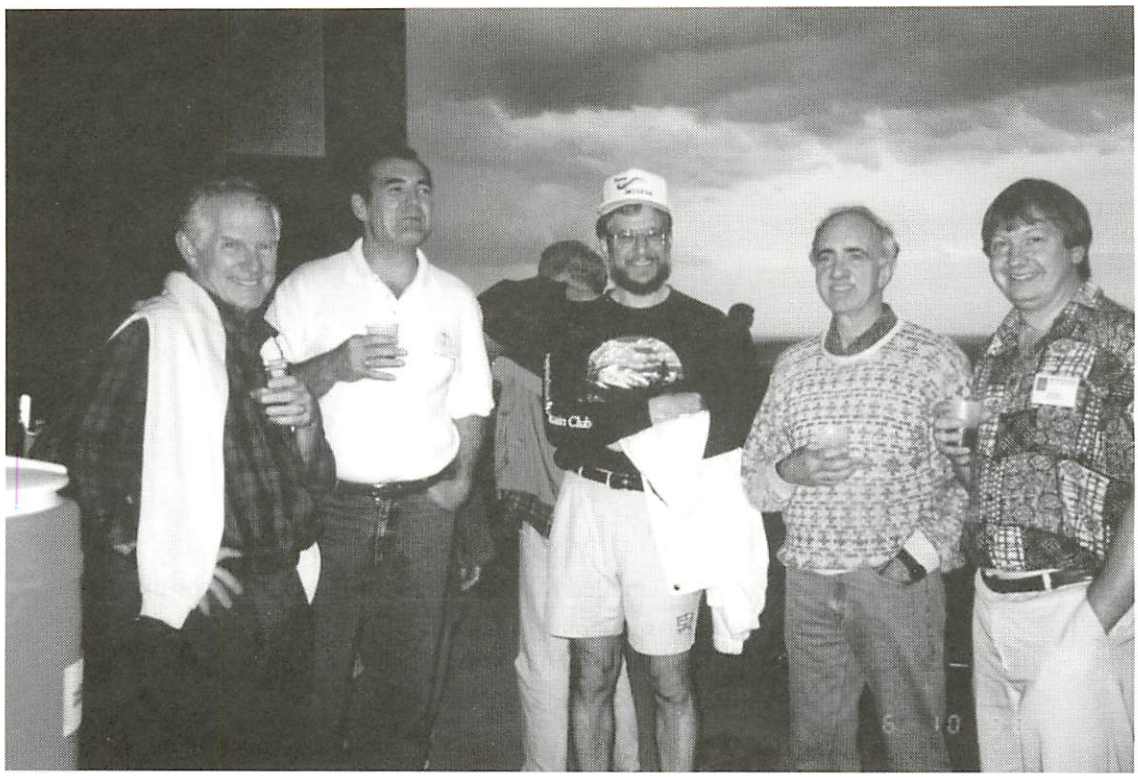
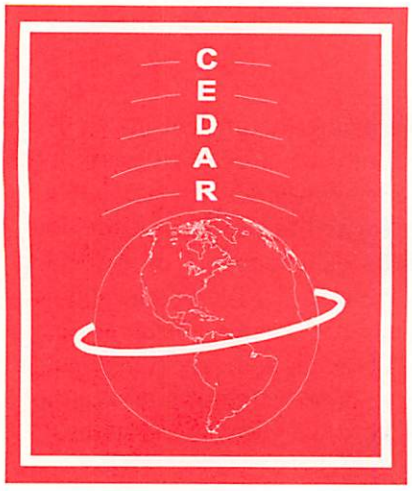


*CEDAR Happy Moments courtesy of Ed Dewan*





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