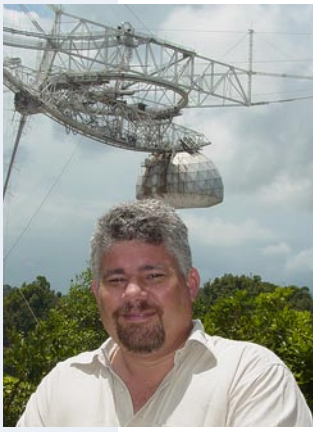
THE CEDAR POST

COUPLING, ENERGETICS AND DYNAMICS OF ATMOSPHERIC REGIONS

EXECUTIVE SUMMARY

I am very pleased to bring you this issue of the CEDAR Post as we quickly approach our annual meeting. The 2004 CEDAR Meeting is taking place in Santa Fe, which seems appropriate in many ways. As the CEDAR program branches out into new areas and brings in new collaborations, a new venue for its annual meeting reflects this new growth. Activity in all areas of CEDAR has been brisk during the last year.



With AMISR coming, many other areas of CEDAR are gearing up to take advantage, and we look forward to exploiting the new scientific prospects AMISR brings us. There has been tremendous activity in determining growth and modernization in optical observing capabilities for the upper atmosphere and ionosphere, as reflected by the recent CEDAR LIDARS self-assessment and by the Passive Optics Workshop in Boulder.

CEDAR collaborations with TIMED, CNOFS, and other programs have been and continue to be fruitful. The number of proposals sent to the recent NSF CEDAR May 1 opportunity shows an unprecedented increase over previous years and is another reflection on the vigor and strength of our community. We look forward to an active and stimulating workshop and another year of growth and progress. A fraction of this growth and progress is reflected in this issue of the CEDAR Post, which consists primarily of 2003 Workshop reports. The 2004 Workshop will show where these efforts have taken us. I expect to continue with regular issues of the CEDAR POST in the coming year.

Sixto A. González
Arecibo Observatory

INSIDE

Everyone moves and talks at the poster session.

Kathryn Fisher and Louise Beierle, the admininstration assistants for CEDAR, at the poster dinner on Tuesday.

The student picnic where Professor Gary Bust of UTA is the hot-dog cook!

Summary of the 2003 CEDAR Workshop

Raintree Plaza Hotel Conference Center
Longmont, Colorado, June 15-20
Barbara Emery, HAO/NCAR

The CEDAR (Coupling, Energetics and Dynamics of Atmospheric Regions) Workshop for 2003 was held in the Raintree Plaza Hotel Conference Center in Longmont, Colorado, about 12 miles northeast of Boulder.

A total of 356 persons from 72 institutions, 18 outside the United States and Puerto Rico, attended the 2003 CEDAR Workshop. This year, 133 students and recent grads came from 27 universities and 5 research labs, including the United Kingdom (5), Brazil (3), Canada (1), Peru (1) and Korea (1). The total number of students increased by 24 from last year, approaching the numbers set between 1992-1995, where the peak student population was 174 in 1993, with total participants of 397.

The Student Workshop on Sunday, organized by the new CEDAR student representative Lars Dyrud of Boston University, examined 'Unsolved Problems in Aeronomy.' Half of the talks were by students or recent graduates. Some of the talks are online in pdf format: *http://cedarweb.hao.ucar.edu/wkshp/videolist.html* Lars will continue next year in his second year as student representative, joined by Stanley Briczinski of the Pennsylvania State University.

The CEDAR Prize Lecture was given by C.-Y. (Joe) She, of Colorado State University, on the winds and temperatures from the CSU sodium lidar observations. The 4 tutorial speakers were D. Pallamraju of Boston University (Airglow Errors), Santimay Basu of the Air Force Research Lab (Ionospheric Scintillations), Michael Sulzer of Arecibo Observatory (Incoherent Scatter Radar Errors) and Meers Oppenheim of Boston University (Particle-In-Cell Simulations). All of these talks are available as .pdf files on the web at: *http://cedarweb.hao.ucar.edu/wkshp/videolist.html*, and are also on videotape. Please contact Barbara Emery (emery@ucar.edu, HAO/NCAR, PO Box 3000, Boulder CO 80307) if interested in obtaining hard copies and/or videos.

There were 25 workshops, including the second annual Student Professional Development Workshop, organized by the second year student representative, Pamela Loughmiller of Cornell University. The longer workshops were on long-term changes in the MLT region, TIMED-CEDAR studies, Arecibo, Fabry-Perots, and the upcoming C/NOFS satellite project. There were also several workshops that emphasized data systems, including the new NSF emphasis on cyber infrastructure. These and other workshops are described elsewhere in this issue.

A large number of CEDAR and related post-docs *(http://cedarweb.hao.ucar.edu/commun/postdocs.html)* came to the 2003 meeting. Diego Janches of the Arecibo Observatory gave his final report, while the 2002-2003 post-docs gave initial reports of their work. These were Alok Taori of Utah State University, Rob Wilson of the Pennsylvania State University, and Jim Boulter of SRI. The 2003-2004 CEDAR post-docs came to the meeting also, but will give their reports in 2004. There were also 3 science highlights and about 13 programmatic talks in the morning sessions.

We enjoyed two evening poster/dinner sessions on Tuesday and Wednesday, where all posters were up the entire time, but only presented one of the two evenings. The Tuesday evening session was devoted mostly to middle atmosphere topics, which was perhaps why this session was the best attended. We ran out of food at the end! (We had plenty of food left on Wednesday night and gave it away to anyone who wanted it!)

We had a record number of posters, 118 total. The previous record was 96 posters at the CEDAR-SCOSTEP meeting at the Raintree in 2001. In previous locations, the poster venue has not always been as good, so non-student posters were sometimes severely limited. We were fortunate to be able to use 2 rooms for the posters, one for each evening session. Sixty-one posters were given by students, which was close to the record set in 1994 with 64 student posters. There were also a record 57 non-student posters. Forty-seven student posters took part in the competition. The 4 winners received $50 for books and a certificate of achievement. The winners were Josef Drexler of the University of Western Ontario in Canada, Carlos Martinis of Boston University, Jonathan Snively of the Pennsylvania State University, and Xiaoli Zhang of the University of Colorado. Honorable mentions were Zhenggang Cheng of Duke University and Luke Moore of Boston University.

Finally, undergraduate honorable mentions were for Christian Lorenzo Olsen of Utah State University and Licia Ray of Boston University. Licia was also a winner last year. The poster chair was Phil Erickson of Millstone Hill who came up with 'Tips for a Great Poster.' These tips are now listed on the web with the judging sheets and other guidelines at *http://cedarweb.hao.ucar.edu/wkshp/post-comp.html*.

The long line for dinner before the first poster session.

The extra-curricular activity for the 2003 CEDAR Workshop was the performance of Moliere's 'Tartuffe' at the Lincoln Center in Fort Collins. Prior to the theatre, many more visited the CSU lidar at its location in an airfield northwest of Fort Collins. Many thanks to Joe She, Dave Krueger and all the CSU graduate students who helped explain the lidar equipment to the rest of us!

The 2004 CEDAR Workshop will take place at the Eldorado Hotel in Santa Fe, New Mexico June 27–July 2. The agenda and other information can be accessed at http://cedarweb.hao.ucar.edu/wkshp.

CEDAR LIDARs Self-Assessment Report

At the 2003 CEDAR Workshop, members of the CEDAR Lidar community met to discuss the production of a self-assessment report. The purpose of this report was to allow the CEDAR lidar community assess current CEDAR lidar capabilities and to determine how the lidar community would continue to address CEDAR science goals. This report, "CEDAR Lidar Beyond Phase III; Accomplishments, Requirements and Goals. A self-assessment by the CEDAR lidar community for the Division of Atmospheric Sciences of the National Science Foundation," was completed in March 2004 and is available at *http://cedar-web.hao.ucar.edu/commun/clr.html*. Two lidar sessions will be held at the CEDAR meeting (one that addresses progress in lidar technologies and one that addresses outstanding science challenges) and all members of the CEDAR lidar community are invited to attend and participate.

In summary, the report recommends that the following actions be given the highest priority by the CEDAR community.

1. Ready access to (or development of) large-aperture telescope facilities
2. The development and deployment of robust mobile lidar systems capable of wind and temperature measurements in the middle atmosphere
3. The development and deployment of Doppler Rayleigh wind-temperature systems to meet the need for measurements of the atmospheric circulation below the mesopause region
4. Support for technical innovation at the level of a center of excellence for lidar research
5. The improvement of existing systems by measures such as enabling daytime capabilities and extending Rayleigh systems with Raman channels
6. The extension of lidar measurements into the thermosphere by exploring new species to serve as lidar targets for upper atmospheric research
7. The development of novel lidar technologies to explore alternative methods for studying the middle atmosphere.

The implementation of these recommendations would allow the CEDAR lidar community to obtain

1. wind and temperature measurements over complete diurnal cycles, which are required for the understanding of tidal, planetary, and gravity wave fluxes as well as wave-wave and wave-mean flow interactions in the middle atmosphere,
2. the very high resolution measurements that are required to understand instabilities and other small-scale processes in the middle atmosphere,
3. the consistent long-term measurements that are required to study long-term trends in the middle atmosphere,
4. new measurements in the thermosphere (E and F regions), where they would provide basic measurements of thermospheric composition and circulation,
5. the species-specific measurements of both neutral and ionized species that are required for study ion-neutral coupling and MLT electrodynamics,
6. the high-resolution measurements of nanometer-size particles required for studies of cloud formation in dusty plasma environments.

These measurements are required to advance our understanding of the middle atmosphere.

This report also recommends that the CEDAR lidar community engage in a formal and technical community dialog that addresses the community priorities identified above: specifically, that the CEDAR community support the following activities at the annual CEDAR meeting in 2004:

1. a dedicated session with panel discussions identifying and prioritizing scientific questions concerning the middle atmosphere that can be addressed by lidar, and

2. a dedicated session with panel discussions presenting technical approaches to developing the next-generation lidar systems that will be employed by the community.

In addition to meeting the specific needs of the CEDAR lidar, the goal of these sessions will also be to promote two other critical processes:

3. discussions between lidar and non-lidar researchers that will increase synergism in the observational programs of the CEDAR community

4. engagement of students who are already working or considering work in middle-atmosphere lidar.

Finally, the report recommends that the NSF Upper Atmosphere Research Section and the CEDAR lidar community work together to accomplish the following:

1. Develop a strategy to ensure continued access to a Class-I large-aperture telescope facility for lidar research

2. Create a specific major proposal opportunity in support of next-generation lidar systems

3. Support, as appropriate, extensions and improvements to current lidar systems

4. Support as appropriate investigations of new technologies and species for middle-atmosphere lidar studies

5. Establish a committee, consisting of both lidar experimentalists and middle/upper atmospheric researchers, to develop an integrated research strategy for the CEDAR lidar community.

TIMED/CEDAR Coordinated Observations of the MLTI Workshop

Convenors: **Larry Paxton** *(John Hopkins University, APL),* **Irfan Azeem** *(Embry-Riddle Aeronautical University),* **Scott Palo** *(University of Colorado),* **Jim Russell** *(Hampton University),* and **Qian Wu** *(HAO/NCAR, qwu@ucar.edu)*

The two part meeting was intended as an opportunity to share the latest information on the TIMED mission and the instruments and the observations and modeling efforts of the CEDAR community. Other contributions from space missions outside of the TIMED/CEDAR community were solicited.

Part 1: Validation

This workshop had as its focus the validation of the TIMED instrument performance and data products. These data products include the observed radiance or irradiance as well as the products generated from these observations. These higher order products include neutral and electron density profiles, winds, temperatures and solar spectral irradiance measurements, among others. NSF/CEDAR partners conduct joint TIMED/CEDAR measurement campaigns in support of the validation effort. This may well be the last of the explicitly defined TIMED validation talks: we found at this meeting that the TIMED experimenters were becoming fully integrated into the CEDAR community. After a little over one year of operation the TIMED project has great progress in assuring the quality of the data and data products. For information on the TIMED mission and instruments and links to the available data products, go to *http://www.timed.jhuapl.edu*.

Speakers and topics:

- **Larry Paxton,** GUVI Validation Activities
- **Brian Wolven,** GUVI Calibration and Characterization
- **Jim Russell,** SABER Calibration and Validation
- **Ruth Lieberman**, Tides in the SABER data
- **Chris Mertens,** SABER temperature retrievals and comparisons
- **Stan Solomon,** SEE Validation
- **Tim Killeen,** TIDI Performance, Calibration and Characterization
- **Rick Niciejewski,** TIDI Validation: Green line winds
- **Qian Wu,** TIDI neutral wind measurements and validation

The instrument status showed that the four TIMED instruments continue to function as they have from orbit insertion. Early issues with water vapor deposition in SABER and TIDI have been addressed. TIDI was, perhaps, the most adversely affected but has shown great improvement after an on-orbit "bake-out".

Part 2: Collaborative Science

The second part of the CEDAR/TIMED workshop went an hour over the nominal 5:30 end time. This session, which was meant as an overview of the status of the TIMED/CEDAR collaborative science investigations, provided 16 speakers an opportunity to show what they have been working on. The science questions that are the major focus of TIMED need CEDAR data:

1. *What is the temperature, density, and wind structure in the MLTI, on a global basis, including seasonal and latitudinal variations?*
2. *What is the relative importance of various radiative, chemical, electrodynamic, and dynamic sources and sinks of energy driving the thermal structure of the MLTI?*

- **Janet Kozyra** – Coordinated storm campaigns
- **Geoff Crowley –** ASPEN/TIMEGCM model results and TIMED data comparison
- **Gang Lu –** Comparison of ISR, ionosondes, and CHAMP data with TIEGCM results
- **Yongliang Zhang** *(presented by Larry Paxton)* – Auroral energy inputs and changes in composition during the May 25-30, 2003 storm
- **Paul Straus –** IOX and TIMED and C/NOFS observations of the declining phase of the solar cycle
- **Jim Hecht –** Observations of O/N_2 from PFRR and Ft Yukon (combined with Conde)
- **Mark Conde –** Impulsive event and the HEX experiment

- **Roland García –** SABER density and temperature measurement
- **Xinzhao Chu –** Initial results of lidar temperature measurements at Rothera, Antarctica (67.5°S, 68.0°W)
- **Joe She –** Collaboration with the CSU Lidar
- **Rick Niciejewski –** Observations of neutral winds by TIDI during the April 2002 and the May 2003 geomagnetic storm events
- **Mike Rouhoniemi –** SuperDarn winds
- **Mike Taylor –** Comparison of ground-based and SABER mesospheric temperatures
- **Shenpang Zhang –** Comparison of TIDI and radar winds
- **Rich Collins –** Recent Lidar developments
- **Ted Llewellyn –** New observations of PMCs with OSIRIS – wintertime detections

These talks showed that the seeds for future interactions with TIMED data have fallen on fertile ground. Continued and enhanced funding is required to take advantage of the TIMED/CEDAR synergy.

TIMED Data System and CEDAR Ground-Based Data Support Workshop

Convener: **Barbara Emery**

About 10 people attended this CEDAR-TIMED data workshop. We asked the approximately 5 would-be CEDAR and TIMED data system users what they were interested in, and then helped them get their preferred data using the wireless internet connectivity in several ways, although there were a few glitches. All got a copy of the 2003 CEDAR Database Catalog. José García, Barbara Emery and Roy Barnes of HAO/NCAR helped users with the CEDAR Database at *http://cedarweb.hao.ucar.edu*, while Stuart Nylund of JHU/APL helped users with the TIMED database at *http://www.timed.jhuapl.edu*.

All the CEDAR/TIMED Ground-Based Instrument (GBI) data in the CEDAR Database are also accessible via the TIMED database, while the TIMED satellite data are in the TIMED database, including new GUVI O/N_2 data that were asked for at this workshop. New GBI data are highlighted at *http://cedarweb.hao.ucar.edu/instr/new.html*, and software to read the CEDAR formats is available at *http://cedarweb.hao.ucar.edu/timed/timed.html* and also in the software and empirical models section.

There were also off-line discussions regarding two imager–ground based researchers who got examples of the minimal FITS format metadata that is under review.

Plasma Kinetics, Structures and Turbulence (PKSAT) Workshop

Convener: **Mishin Evgenii**

Observations and theory/modeling of PKSAT in the ionosphere/thermosphere system focusing on the momentum and energy balance were discussed. Topics of discussion included:

- Observations of PSAT in the perturbed ionosphere
- Plasma turbulence and kinetic effects in the energy balance in the ionosphere
- Wave effects in M-I coupling at subauroral latitudes
- Recent achievements in modeling of ionosphere plasma turbulence

Program

- **M. Oppenheim and Y. Dimant –** Fully kinetic simulations of low-frequency turbulence in the electrojet
- **Y. Dimant and G. Milikh –** Anomalous Electron Heating in the Electrojet
- **D. L. Hysell, M. F. Larsen, and J. L. Chau –** Coherent scatter observations of E region plasma irregularities
- **B. Bristow –** Atmospheric gravity waves in the auroral ionosphere
- **P. Guzdar –** Structuring of polar patches
- **L. Dyrud –** Electron hole resistivity in space plasmas.
- **E. Mishin, A. A. Viggiano, and W. Burke –** Electron and ion molecule kinetics at high temperatures: Ionospheric applications

Presentations included recent results of theoretical, numerical, and experimental studies of different plasma wave phenomena in the ionosphere. First results on fully kinetic simulations of low-frequency instabilities in the

electrojet indicated that, in addition to the well-known Farley-Buneman instability, the so-called thermal instability plays a very important, sometime even dominant, role. Excellent agreement of the theoretical model of electron heating by strongly turbulent Farley-Buneman waves with observations was demonstrated.

Recent advances in coherent scatter radar techniques and technology in investigating E/F-region irregularities were described, accompanied by movies of recent observations. A comprehensive concise review of AGWs generated in a perturbed ionosphere was presented. Three-dimensional simulations of the gradient-drift instability under variable IMF conditions demonstrated an excellent agreement with the observed fine structure of polar patches. Kinetic simulation results on electron beam interaction with the ionosphere plasma confirmed initial results and showed how electron holes may contribute to anomalous resistivity in the top ionosphere.

Effects of electron and ion-molecule-kinetics at high electron and vibrational temperatures of molecular neutral/ionized species were reviewed with special regards to the ionosphere F region. New analytical approximations of the rate coefficients based upon recent experimental results were presented. Those include production rates and quantum yields of the $O(^1D)$ and $O(^1S)$ states from the dissociative recombination of oxygen ions, charge transfer, and charge exchange reactions.

Among possible ionospheric applications, SAR arcs, density troughs associated with subauroral polarization streams, and HF modification experiments were discussed.

Equatorial Ionospheric Imaging Workshop

The Equatorial Ionospheric Imaging section of the 2003 CEDAR Workshop was held mid-week in the room holding the morning plenary session. The goal of this session was to bring together scientists working with ground and space-based observations of the ionospheric airglow at the equator. Conveners of the session were **Thomas Immel, Jonathan Makela, Paul Straus, and Larry Paxton.** In the short two hours, 11 speakers made presentations. We were very pleased to have four presentations from graduate students.

› **Paul Straus** *(Aerospace Corp)* led off the session with a comprehensive survey of the nightside GUVI data, discussing climatology of the ionospheric heights and densities from the first full year of TIMED/GUVI limb observations at 135.6-nm. Many ionospheric parameters are being retrieved from the limb observations. Examples such as ionospheric heights and densities and their variability around the globe were shown. It is clear that GUVI is collecting the most extensive set of equatorial far-ultraviolet limb observations to date.

› **Sid Henderson** *(a Ph.D. student from Utah State)* discussed the GUVI FUV climatology and global distribution of FUV brightnesses/plasma densities determined from the disk images. One of the outstanding features is a density enhancement in the South American sector, which is attributed with the high declination of the magnetic field in that sector.

› From the ground-based side, **Jonathan Makela** *(Naval Research Laboratory)* presented results from ground-based optical observations from Mt. Haleakala, Hawaii showing the growth of equatorial plasma bubbles. The images/movies show the rapid growth of multiple plasma bubbles in the post-sunset ionosphere. Jonathan also showed images mapped into the same coordinates as a GUVI disk image, showing excellent correspondence between ground and space based plasma bubble identification.

› Next, **Brent Ledvina** *(a Ph.D. Candidate from Cornell U.)* discussed recent observations of GPS scintillations from receivers deployed at Cornell and Brazil. The receivers allow one to determine the magnitude and velocity of the scintillations. Brent also reported that scintillation data from a constellation of receivers is available in real-time at *http://gps.ece.cornell.edu*.

› **John Foster** *(Millstone Hill, MIT)* gave a presentation regarding total electron content (TEC) enhancements associated with storm-time redistribution of ionospheric plasma. Over the southern US, the TEC can easily increase to over 100 TEC units as the uplifted equatorial ionospheric plasma is transported to middle latitudes. This appears in maps of TEC over North America ob-

tained from an array of GPS receivers distributed across the continent and in the Caribbean. High TEC plumes extend north and west, well into Canada, during these storm time redistributions of plasma.

› Back to GUVI, **Joe Comberiate** *(a Ph.D. student from the U. of Illinois)* discussed techniques for inverting GUVI radiances to obtain electron densities. This technique is used to create multidimensional images of plasma bubbles through inversion of GUVI brightness measurements at 135.6 nm. The problem is inherently difficult because of the sharp gradients expected at the bubble edges, even while one hopes the inversion will otherwise report smooth variations around the bubble. Joe reported success, however, and compared inversions to ground-based images from Haleakala.

› Next, **Hyosub Kil** *(Applied Physics Lab)* reported on plasma bubble observations from GUVI. Images of bubbles are shown in conjunction with in-situ data from the equatorial orbiting ROCSAT-1, which measures plasma densities and velocities. The correspondence between brightness and electron density depletions is clear. Comparisons to radar data from Sao Luis were also shown. The longitudinal distribution of bubble occurrence was shown to match that seen from other (in-situ) studies, with greatest occurrence in the South American sector in December and in the African sector in June.

› Next, **Thomas Immel** *(UC Berkeley)* spoke regarding the results from the IMAGE mission regarding equatorial airglow emissions, also at 135.6 nm. Unlike GUVI, the FUV imager operates in a highly elliptical orbit with an apogee of 7.2 Re. It obtains global scale images and can observe individual plasma bubbles for many hours as they propagate across the nightside. The average propagation speed as a function of local time was determined and compared to Jicamarca average plasma drift speeds. The comparison is good, though the FUV determined drifts are generally greater. A movie of the FUV emissions during a storm period was also shown (May 29, 2003), which resembled quite closely the storm time redistribution of plasma seen in John Foster's TEC imaging results.

› **Chin Lin** (Southwest Research Inst) discussed the storm time redistribution of ionospheric plasma observed by ROCSAT-1 for the Bastille Day (2000) storm. In that case, the redistribution of plasma around the South Atlantic magnetic anomaly was particularly severe, with a large TEC "pile-up" to the east of the magnetic anomaly. This adds to the picture of the TEC variations seen by ground-based receivers and shown earlier by Dr. Foster. Dr. Lin also showed comparisons of ROCSAT passes with IMAGE data, comparing keograms of traveling density depletions to multiple passes by ROCSAT, which indicated that in several cases, ROCSAT observed the same plasma bubbles in successive orbits.

› More ground-based imaging results were presented by **Carlos Martinis** *(a Ph.D. student from Boston Univ.)*. He showed comparative observations from two low latitude all-sky imagers. One imager was located at the magnetic equator, the other to the south in the region of the ionospheric anomaly. Each imager individually observed and allowed determination of zonal ionospheric plasma drift speeds from the drift speed of plasma depletions over an imaging season. In a surprising result, the drift speeds away from the equator were found to be higher for several hours after sunset, with a reversal of this trend later in the evening. Numerical modeling shows that this is actually the expected result. The integrated effect of F-region conductivity along magnetic field lines is greater several degrees of latitude away from the equator than right at it, leading to more rapid drifts early in the evening.

› Comparisons between ionospheric modeling results and GUVI nighttime disc data were shown by **Dave Anderson** *(U. of Colorado/CIRES)*. Important model inputs are daily magnetometer measurements which allow one to infer the daytime E×B ionospheric plasma drifts, which strongly influence the eventual distribution of plasma in the nightside ionosphere. In this case, the magnetometer data come from the Peruvian sector. Fifteen separate comparisons of the modeled anomaly crest separation with the same parameter determined from GUVI observations show a good correlation. Even better correlation comes from comparisons of the root of the FUV brightness with modeled values of N_mF_2.

In this workshop, we asked for presentations from ground-based observers who had results pertinent to the space-based missions, from space-based observers who had new results and were looking for ground-based support or confirmation, or any researcher who was actively

using data from either resource to interpret results from the other. To the great satisfaction of the conveners, this is exactly what we got. Every presenter had new, exciting results and presented results useful to a range of studies of the equatorial ionosphere. Many thanks go to all the presenters and the organizers of the CEDAR 2003 Workshop for making this a great and useful venue for discussion.

Middle- and Low-Latitude Ionospheric Disturbances (M-I Coupling) Workshop

Conveners: **Chaosong Huang, Bela Fejer, Jorge Chau**

A workshop on ionospheric disturbances at middle and low latitudes was organized to discuss the recent progress and future direction in this area. Observations from satellites, incoherent backscatter radars, all sky imagers, GPS receivers, and ground magnetometers, and numerical simulations were presented. Topics include effects of magnetic storms and substorms, penetration of interplanetary electric fields, large-scale equatorial spread F irregularities, and equatorial anomaly. Special attention was paid to the generation mechanisms and global characteristics of these disturbances. This workshop may be the first one that covers all major disturbances in the middle- and low-latitude ionosphere.

› **Tim Fuller-Rowell** *(NOAA)* first showed the simulation results of ionospheric disturbances during magnetic storms. Large-scale atmospheric disturbances are launched in the auroral zone and travel to low latitudes. The composition changes in the disturbance atmosphere cause the negative storm effect in the F-region electron density, and the anomaly process is enhanced by storm-time global circulations.

› **John Foster** *(MIT)* presented global distributions of total electron content (TEC) measured by GPS networks. A spectacular phenomenon is that a greatly increased TEC band occurs from the subauroral latitudes to the polar cap during severe magnetic storms. The TEC band is related to plasmaspheric plumes. Mapping of the ionospheric TEC structures up to the magnetospheric equatorial plane shows an excellent agreement with satellite images.

› **Michael Kelley** *(Cornell University)* reported on an event of penetration of interplanetary electric fields into the equatorial ionosphere. The ratio of the dawn-dusk interplanetary electric field to the penetration electric field in the equatorial ionosphere is about 7 percent. The penetration electric fields are most obvious if the time scale of the interplanetary electric fields is shorter than ~1 hour, because the ring current shielding mechanism does not work effectively under such conditions.

› **Bela Fejer** *(Utah State University)* further discussed the effects of penetration electric fields on equatorial ionospheric electrodynamics. An eastward electric field will move the equatorial ionospheric plasma upward. In particular, an enhanced pre-reversal enhancement of the vertical motion will result in the occurrence of equatorial spread F plasma bubbles.

› **Joe Huba** *(Naval Research Laboratory)* presented the simulation results of midlatitude ionospheric disturbances caused by penetration electric fields. An east-west perturbation electric field causes an up-down motion of the ionosphere, and the different recombination gives rise to a variation of ~30% in the F-region electron density. The simulations are in good agreement with the Millstone Hill radar measurements.

› **Cesar Valladares** *(Boston College)* showed GPS measurements of TEC perturbations in association with equatorial plasma bubbles. The bubble signatures in TEC occur both over the equator and at anomaly latitudes, and in both the premidnight and postmidnight sectors.

› **Qihou Zhou** *(Miami University Ohio)* talked about sporadic E structures during magnetic storms. A correlation may exist between E_s structures and storm activity, and some unusual E_s features are observed.

› Finally, **Chaosong Huang** *(MIT)* presented observations of low-latitude ionospheric disturbances caused by magnetospheric substorms. The substorm-related electric fields penetrate to the equatorial ionosphere, lift the F-region plasma, and enhance the fountain effect. As a result, periodic variations occur in the equatorial F region plasma density and in TEC at the anomaly, in response to periodic substorms. Periodic substorms also cause peri-

odic geomagnetic disturbances at low latitudes, and the amplitude of the magnetic disturbances is as high as 120 nT.

There were about 100 participants in this workshop. The response to the presentations was overwhelming. The scientists showed great interest in the new progress and discussed the outstanding problems that remain unsolved. The middle and low-latitude ionosphere is a fascinating area, and further collaborative investigations on global disturbances are necessary.

AMISR at Jicamarca Workshop

Conveners: **Jorge Chau, John Kelly, Donald Farley**

A small part of the Advanced Modular Incoherent Scatter Radar (AMISR) consisting of eight of the basic panels (each with 4×8 dipoles) will be deployed at the Jicamarca Radio Observatory (JRO) in 2004. Over Jicamarca, there are coherent scatter targets of significant scientific interest (equatorial electrojet (EEJ), 150-km echoes, equatorial spread F (ESF)) and with anticipated returns that should be readily detectable by this small radar. Although the main purpose of installing this radar at Jicamarca is to test its performance, this workshop was intended to provide a forum for brainstorming ideas on how to get the most of this instrument.

Craig Heinselman started the session with a brief description of the recently funded AMISR project and with particular emphasis on the small portion that will come to Jicamarca. Then David Hysell proposed and discussed a number of scientific topics that could be pursued with such a system. Jorge Chau complemented that list with ideas formulated by J. Chau, D. Farley, C. Heinselman, D. Hysell, E. Kudeki and R. Woodman. The scientific topics included meteor, equatorial electrojet, 150-km echoes, equatorial spread F, and E-region plasma line studies. These and other topics (e.g., measurements of space debris) were discussed briefly during the session. The feasibility of pursuing most of them will depend on the final sensitivity of the system.

Although we are not sure if the sensitivity will be enough (e.g., there are no previous measurements of EEJ irregularities at UHF frequencies), we discussed different possible configurations of the small AMISR that could satisfy the proposed experiments, e.g., long array along the NS direction, tilted modules looking west of Jicamarca to take advantage of the known increase of power at oblique angles, etc. Based on these requirements and after Craig's visit to JRO, before the CEDAR meeting,

- We have selected a ~40m×40m area available for the system and close to the main building.
- John Kelly has suggested using a mobile (with a possibility of rotation with respect to vertical) platform for each of the panels, similar to the structure currently used in the prototype to assemble the panel.
- The system would be installed by April 2004.

There were ~40 people participating in this session. Although most of the proposed topics were presented by current Jicamarca users, other users and ideas were welcome. Anyone who is interested in receiving future correspondence or is willing to propose ideas should send an email to *chau@jro.igp.gob.pe.*

Using The Data Transport Network For Remote Data Retrieval and Distribution Workshop

Convener: **Todd Valentic**

A short workshop was held to bring together people interested in the development and usage of the Data Transport Network. This system is an NSF-funded project for reliably accessing data and monitoring the health of instruments at remote field sites. It is currently being used to deliver data in near real-time from a number of radars, lidars and imagers at the Sondrestrom Radar Facility in Greenland as well as monitoring meteor scatter radars at the South Pole. The Data Transport Network will play a large role in the operation and monitoring of the new Advanced Modular Incoherent Scatter Radar (AMISR).

The workshop was attended by about twenty people and primarily consisted of a presentation of the system and some potential applications. The setting was informal and was often diverted in detailed discussions about specific topics by the audience members.

For more information about the Data Transport Network, please visit the project web site at: *http://transport.sri.com/TransportDevel.*

Arecibo Friends Workshop

Conveners: **Sixto A. González**

The Arecibo Friends Workshop was a full afternoon discussion encompassing various science topics related to Arecibo observations. The discussion was animated, yet amicable, as it dealt with a number of yet unresolved issues, particularly related to the topside ionosphere. At the end of the workshop, there was a small-group discussion on multi-instrument observations of an unusual sporadic E event from Summer 2002. The workshop agenda was as follows:

- **Sixto A. González** (Arecibo) Introduction
- **Robert Brown** (Cornell/NAIC) Message from NAIC Director
- **Michael Sulzer** (Arecibo) Radio Science Update
- **Stan Briczinski & Chun-Hsien Wen** (PSU) Penn State ITR project
- **Chris Wilford**(Sheffield) topside/modeling/dawn T_{-e} overshoot
- **Mike Nicolls** (Cornell) topside/web page enhancements/winds
- **Rebecca Bishop** (Clemson) summer 2002 E-region campaign/CEDAR post doc
- **Dave Hysell** (Cornell) E-region studies using coherent and incoherent scatter radars: sporadic E and QP echoes
- **Sixto A. González** (Arecibo) Airglow update/intro/building/upgrades/imagers
- **Eva Robles** (Arecibo) data analysis/filter project/630 FPI winds
- **Robert Kerr** (SSI) exosphere/7320
- **Lara Waldrop** (BU) coupled ionosphere/thermosphere/plasmasphere and exosphere studies
- **Paloma Farias** and **Johannes Wiig** (PSU) New PSU/Arecibo all-sky imager
- **Shikha Raizada** (Arecibo) Lidar update
- **Diego Janches** (Arecibo/PSU) meteor workshop report/discussion about upcoming workshops
- **Rob Wilson** (Arecibo/PSU) & Steve Smith(BU)/ June 14-15 study clustered intrument study

Alaska Project Workshop

Conveners: **Yasuhiro Murayama, Roger W. Smith**

The Communications Research Laboratory (CRL) and the Geophysical Institute, University of Alaska Fairbanks have an international cooperative project to develop the techniques for observing Arctic atmosphere and to research the mechanisms of the middle and upper atmosphere in the polar region. This project was initiated in 1992, developing nine instruments including imaging riometer, Fabry-Perot interferometers (FPI), MF and HF radars, Rayleigh lidar and all sky imagers. Scientific targets of the project include understanding of vertical coupling processes of Arctic atmosphere, and also the effect of solar activity to the atmosphere. The thermosphere is sensitively responding to electric field/energetic particle forcing where the effects go down to lower thermosphere. In the middle atmosphere, the mesosphere is closely coupled with the stratosphere through atmospheric waves, and general circulation.

For effective use and display of the data observed in Alaska and for assistance in data distribution, the System for Alaska Middle Atmosphere Observation Data Network (SALMON) is now being designed and developed using a high-speed computer network. The system will have capabilities of quasi-real time data transfer to remote sites from Alaska, real time data displays on the world wide web and on a multi-screen display facility, as well as on-line data distribution to those who wish to look at or analyze the data.

In this workshop, reviews were given of recent instrumentations, updating, and scientific results at Poker Flat and related experiments; thus, a spread of experiments and studies were introduced for promoting related research groups to exchange each other.

Alaska Project Workshop

Time	Presenters	Affiliations	Topics
13:00-13:05	Smith/Murayama	GI/UAF CRL	Opening remarks
13:05-13:20	Murayama	CRL	Overview of CRL's middle/upper atmosphere project at Poker Flat
13:20-13:35	Collins	GI/UAF	Lidar observations at Poker Flat
13:35-13:50	Sakanoi	CRL	Winter middle atmosphere disturbances observed by MF radar and Rayleigh lidar at Poker Flat
13:50-14:05	Ishii	CRL	Neutral-Ion coupling observed with CRL-FPI
14:05-14:20	Conde	GI/UAF	GI-SDI (Comparison of FPS analysis methods)
14:20-14:35	Ishii (on behalf of Kubota)	CRL	Aurora and airglow observations with CRL-ASI
14:35-14:50	Murayama	CRL	Mesospheric CO Observation by Poker Flat FTIR spectrometer
14:50-15:00	Murayama	CRL	The System for Alaska Middle Atmosphere Observation Data Network (SALMON)

Upper-Thermospheric and Exospheric Ions Workshop

Conveners: **John Noto** (noto@sci-sol.com) **Sixto González** (sixto@naic.edu)

About 60 people attended the workshop. **Ed Mierkiewicz** discussed recent Balmer-beta measurements made at the University of Wisconsin and described his ongoing effort to derive thermospheric hydrogen densities. **Susan Nossal** presented her continuing work with the all-sky H-alpha survey instrument, WHAM, and described their observations of Balmer-alpha emission as a function of solar-cycle and discussed longer term climatology of hydrogen. **Sixto González** presented an update of recent Arecibo and Jicamarca light ion composition measurements.

John Meriwether presented a new three etalon FPI system (SOFDI) and discussed possible measurements including O^+ (732nm) and thermospheric gravity waves. The topic of a possible hot oxygen geocorona was initiated with discussion of two papers, Yee 1980 and Cierpka 2003. **Bob Kerr** then presented recent 732nm FP observations made with a single etalon system at Arecibo and discussed the observed temperatures which disagreed with the Yee result. Also discussed were future nested Arecibo optical observations utilizing several Fabry-Perot systems.

Global Change Across the Mesopause

Conveners: **Rashid Akmaev, C.-Y. "Joe" She**

The problem of long-term changes, both natural and anthropogenic, in the upper atmosphere and ionosphere is directly related to three key science areas of CEDAR: Coupling with Lower Altitudes, Solar-Terrestrial Interactions, and Long-Term Variations. The pioneering modeling study by Roble and Dickinson (1989) initiated a search for anthropogenic signatures in observations of the neutral mesosphere and thermosphere and in long-term ionosonde records. According to our current understanding based on several modeling studies, the changes are expected to manifest primarily in the form of "greenhouse cooling" through the whole middle and upper atmosphere. The cooling should be accompanied

by a long-term thermospheric density decline, a downward displacement of ionospheric layers, and possibly other observable phenomena. Although these changes are expected to be substantial, their detection from available observational records may be obscured by the often larger variability primarily driven by solar and geomagnetic activity and their possible secular variations. The purpose of the workshop was to provide an overview of the current state in this area, including observations, modeling work, and relevant analysis techniques. It is therefore not coincidental that the workshop attracted a substantial number of participants (ca. 50).

› After a brief introduction by Joe She, the first half of the workshop primarily dealt with analyses of various observational data sets. **David Krueger** and **Joe She** *(Colorado State U.)* presented their now 12-year record of lidar observations of mesopause region temperatures over Fort Collins, CO. The length of the record now allows, in principle, to filter out a possible solar-cycle signal. An apparently strong temperature increase by up to 10–15 K at some heights observed in the early 1990s can be attributed to the Pinatubo eruption in 1991. With no special explicit treatment of this strong perturbation at the beginning of the record, it could have been easily mistaken for an enormous cooling trend at the mesopause. The workshop attracted a few colleagues from Europe.

› One of them, **Martin Jarvis** *(British Antarctic Survey),* presented an overview of trends derived from the worldwide network of ionospheric sounding stations, the area of research pioneered in Europe and Russia. Some of the records go back as far as 50–60 years, however, their interpretation in terms of long-term trends remains nontrivial depending on the station location, preprocessing of the data, quality of the record, statistical model used, etc.

› This theme was continued by **Betsy Weatherhead** *(U. Colorado)* who used several examples of real and simulated lower-atmospheric data to demonstrate how the physics of the system and various possible problems with data records may affect our ability to detect trends. She also mentioned some problems existing in the publicly available, long-term ionosonde records that apparently have not been addressed before. Among them: obvious outliers, record discontinuities due to instrument/procedure changes, repeated data, data gaps, and others.

› **Gerald Keating** *(George Washington U.)* presented a convincing analysis of long-term satellite drag data. He and coauthors have arrived at an approximately 10% thermospheric density decline over the two solar cycles 1976–1996, which is a reasonably good agreement with available model predictions.

› The session concluded with a brief poster preview by **Jonathan Wrotny** *(Hampton U.)* discussing the identification and characterization of Polar Mesospheric Clouds (PMCs) in HALOE data. PMCs or noctilucent clouds (NLCs) have long been considered a possible indicator of global change in the upper atmosphere (however, see a recent article by Ulf von Zahn in EOS).

› The second session was primarily devoted to modeling studies and comparisons with observations. **Dan Marsh** *(NCAR)* discussed trends in mesospheric ozone as observed by HALOE from UARS over the last decade. An explanation was presented of the fact that while the sunrise observations show very little seasonal or longer-period changes, the sunset data reveal a strong decrease (about –23%) apparently in response to the decadal changes in water vapor (about –13%) observed by the same instrument. The ozone photochemistry at sunrise turns out practically independent of the water vapor content, whereas the main mechanism of ozone destruction at sunset is by HO_X radicals. Simulations with a global chemical-dynamical model have confirmed the conclusion.

› Another European colleague, **Uwe Berger** *(Inst. Atmos. Phys., Kühlungsborn, Germany)*, and coauthors presented numerical simulations of the summer polar mesopause region with a 3-D dynamical model that incorporates a photochemical module to simulate the properties of NLCs. Their general conclusion is that the region's energy budget is dynamically controlled during summer and strongly depends on variable circulation factors, which makes detection of any long-term trends imprecise.

› **Ray Roble** *(NCAR)* presented recently updated predictions of the possible structure of the upper atmosphere and ionosphere at the turn of the century 2100.

› **Rashid Akmaev** *(U. Colorado)* discussed possible effects of new data and additional physical processes on the CO_2 "greenhouse cooling" in the upper atmosphere. These include new laboratory measurements of the collisional excitation rate by atomic oxygen and radiative solar heating in the near-infrared bands of carbon dioxide. Both should, in principle, weaken the cooling effect; however, the thermal response in the thermosphere will not necessarily be smaller due to the presence of feedback mechanisms.

› **Stan Solomon** *(NCAR)* presented three examples of rocket and satellite observations indicating a substantial deficit of atomic oxygen and total density in the thermosphere compared with standard empirical models. These results appear to be qualitatively consistent with the idea of "greenhouse cooling."

Although the unavoidable AGU-style of the presentations left little time for discussions, judging by the number of questions and occasional statements from the audience, the workshop generated substantial interest within the CEDAR community and may be considered for an encore in Santa Fe, NM, in 2004.

Transient Optical Emissions in the Upper Atmosphere

Conveners: **Victor Pasko, Mike Taylor, Mark Stanley**

This workshop was held on Wednesday afternoon (June 18, 2003), starting at 1:00 p.m. and finishing around 3:00 p.m. Like in previous years, the workshop was very well attended with total number of participants around 40 to 50. This year's workshop discussed various questions related to the physical nature and energetics of sprites, and emphasized recent and forthcoming sprite related experiments, including the 2002 Sprite Balloon experiment in Brazil and the Imager of Sprites and Upper Atmospheric Lightning (ISUAL) experiment on ROCSAT 2 satellite, which is planned for launch in mid-2003.

› After a brief introductory discussion on previous measurements of electric fields above thunderstorms and on theoretical aspects related to quasi-static thundercloud fields as a driver of sprite phenomena, **Bob Holzworth** began the workshop by reporting results from a balloon experiment conducted in 2002 in Brazil. The most interesting result is recording of a very large electric field transient from a +53 kA cloud-to-ground lightning at 33 km altitude exceeding 140 V/m and exhibiting similar vertical and horizontal components. X-ray measurements were conducted during the campaign, but no association of X-ray emissions and sprites has yet been identified.

› **Mike Taylor** continued discussion of the same Brazil sprite experiment, providing a detailed description of imaging instrumentation used for ground and airplane based observations, and correlations with satellite infrared data and local lightning detection network. Total of 16 spectacular sprite events and also possibly several elf-type events were observed in November-December 2002 and March 2003 during the observations over central and southern Brazil.

› **Walt Lyons** presented a report on results from the Severe Thunderstorm Electrification and Precipitation Program (STEPS), conducted on the High Plains during the summer of 2000. Two case studies of supercell thunderstorms were presented indicating that this type of storm only produced strong sprite events during its collapsing stage, accompanied by development of a substantial stratiform precipitation region. Some small sprites were observed during active part of a supercell storm, indicating unusually high positive charge densities ~8 nC/m^3 in the core of the storm.

› **Stephen Mende** provided an update on the status of the ISUAL instrument on the planned ROCSAT-2 mission. ROCSAT-2's orbital characteristics as well as observational strategy and science objectives of ISUAL instrument were presented. The ISUAL instrument consists of a limb view sprite imager bore-sighted with a six-channel spectrophotometer. The ROCSAT-2 will be operating at 891 km in a sun-synchronous polar orbit with an expected lifetime of 5 years. The primary science objectives of the mission include global survey and documentation of location and timing of luminous phenomena above thunderstorms, and global observations of aurora and airglow.

› **Steve Cummer** reviewed current understanding of sprite mechanisms and emphasized the importance of

the lightning charge moment change as one of the key characteristics of lightning sprite producing potential. The unsolved questions in sprite research were reviewed, in particular, a puzzling appearance of sprites with very small charge moment changes of 100-200 Ckm. Specific analysis using data obtained during the STEPS 2000 campaign indicate that charge moment changes of >1000 Ckm in 5 ms almost certainly make a sprite, while ~600 Ckm represents a good estimate of sprite production threshold, and contribution to sprite initiation from factors other than the charge moment is not dominant.

› **Ningyu Liu** emphasized that results from a new model, allowing studies of filaments of ionization (termed streamers) initiated from single electron avalanches in air in strong applied electric fields, indicated that streamers always exhibit strong acceleration and expansion. The model results allow a straightforward interpretation of recent high speed and telescopic video observations of sprite streamer structures with transverse scales 50-200 m and speeds with up to one tenth of the speed of light.

› **Victor Pasko** reported results of observations of 8 sprite events above a Haiti/Dominican Republic thunderstorm conducted from the Arecibo Observatory, Puerto Rico on September 3, 2001. ELF recordings identified the 7 of the observed events as to be associated with positive cloud to ground lightning discharges involving the vertical charge moment changes ranging between +143 Ckm to +2520 Ckm, while one small sprite event was confirmed as being produced by a negative cloud-to-ground lightning with the charge moment change -278 Ckm in 1.2 ms.

› **Mark Stanley** concluded the workshop with a report of an exciting experimental discovery indicating that positive cloud-to-ground lightning discharges, which initiate sprites below the base of the ionosphere, can also initiate upward positive leaders from tall (>400 m) structures on the ground.

Many of the workshop attendees added to the workshop success by their useful comments and questions. We thank everyone for their participation. Please contact any of the workshop conveners with any questions about the 2003 workshop, or any suggestions for future CEDAR sprite workshops.

2003 Workshop Report: Electric Field Variability in the High-Latitude Ionosphere and Joule Heating

Conveners: **S. G. Shepherd, J. M. Ruohoniemi, M. V. Codrescu**

Following a successful workshop on variability in the high-latitude ionosphere in 2002, a similar session this year focused on electric field variability and specifically how it impacts Joule heating. In the past decade, it has become evident that small-scale variability in the convection electric field is an important factor contributing to Joule heating in the high-latitude thermosphere. Several recent studies have used a variety of measurements and techniques to quantify the degree of this variability. The purpose of this session was to discuss some of these results and try to determine how best to characterize electric field variability.

After a brief introduction and discussion, we heard from nine speakers who presented their views and research on a range of issues relating to electric field variability and Joule heating, including satellite observations, radar observations from 3 different types of radars, modeling, and theoretical ideas and implications.

› **Michael Codrescu** *(NOAA/SEC)* began by reminding us of the origins of the role small-scale variability plays in Joule heating and setting the 'workshop' atmosphere of the session by stimulating lively discussion. Barbara Emery (HAO/NCAR) showed the first of several studies aimed at characterizing variability in observation of the electric field. Barbara showed variability and Joule heating maps that created from ~3000 polar DE-2 passes. Jean-Pierre St-Maurice (U. of Western Ontario) presented a derivation of Joule heating which emphasized the importance of the neutral winds. The ensuing discussion of neutral winds determined their importance in the problem, but also revealed difficulties in incorporating them into calculations of Joule heating on large-scales.

› **Tomoko Matsuo** *(HAO/NCAR and ITPA/SUNY at Stony Brook)* presented work from her recently defended Ph.D. dissertation "Effects of High-Latitude Ionospheric Electric Field Variability on the Estimation of Global Thermo-

spheric Joule Heating". Tomoko focused on her Empirical Orthogonal Function analysis of DE-2 electric field data. She demonstrated that it is possible to also determine the spatial extent of the observed variability, which is important in understanding what regions are most effective at transferring momentum to the neutral wind.

› The first of several observational studies using ground-based radars was given by **J. Michael Ruohoniemi** *(JHU/APL)*. Mike showed that the variability maps derived from SuperDARN measurements of the drifting F-region plasma had many similarities to maps derived using other instruments.

› **Jeffrey Thayer** (SRI) presented a novel idea using the incoherent scatter radar (ISR) to probe even finer scales of variability. Jeff showed that it was possible to use the ion temperature from ISRs as a proxy for electric field variability, thus dramatically reducing the spatial resolution to ~1 km.

› **Hasan Bahcivan** *(Cornell)* presented data from a new E-region 30 MHz radar with 3 km resolution. Variations in the electric field were seen down to the smallest scale.

› **Timothy Fuller-Rowell** *(NOAA/SEC)* gave a demonstration of how equatorial electrodynamics were affected by electric field variability in the high-latitude. The largest effect was seen as an Eastward wind at the equator.

› Finally, **Aaron Ridley** *(U. of Mich.)* looked at variability of the cross polar cap potential using IMF drivers of variable frequency and amplitude with the BATS-R-US MHD code.

› During the ensuing discussion period, **Simon Shepherd** *(Dartmouth College)* gave a very brief presentation of an event in which motion of the large-scale convection pattern was shown to be the cause of large variations in the observed SuperDARN velocities near the dayside convection reversal boundary. Among the topics discussed at the end of the session were, the roles that the neutral winds and conductivity play in determining Joule heating rates, scale sizes of variability, and the need to define a common language when referring to variability.

Overall, the session was well attended, there was a broad spectrum of presentations, and the discussion was lively. This was the second CEDAR workshop on variability, and the rapid pace of developments points to the need for follow-up sessions at future CEDAR workshops.

C/NOFS Collaborative Measurements and Campaigns Workshop

Conveners: **O. de La Beaujardière, D. Hysell, M. Kelley, B. Basu**

C/NOFS (Communication and Navigation Outage Forecast System) is a satellite system dedicated to forecasting ionospheric densities, irregularities and scintillation. It will be launched in November 2004, in a 13 degree inclination, 700 × 400 km orbit. It will have instruments that will provide plasma parameters, electric fields (AC and DC), density fluctuations, and neutral wind. It will also have a GPS receiver, and an RF beacon. Ground-based instruments to monitor the ionosphere and the scintillation parameters are an integral part of the mission.

During the workshop, particular emphasis was placed on forecast, dynamics, disturbance E-fields, climatology, empirical relationships, validation, and ground-based observations / campaigns.

After a few talks about the C/NOFS mission and the physics-based forecasting models, ground and space data sets were described and campaigns were planned. The group planned three types of campaigns:

› The Pacific sector campaign, which would be aimed at determining if equatorial spread F is triggered by waves propagating from below.

› The field line campaign, which is devoted to measuring as many parameters as possible along a given magnetic flux tube—the E-region conductivities in particular.

› Global campaigns, during which longitude variations of global ionospheric density and F-region irregularities would be measured.

The CNOFS mission provides an excellent opportunity for coordinated observations, theory and modeling to better predict the equatorial ionosphere and plasma irregularity mechanisms.

CEDAR 2003 GIFT Workshop Summary

Conveners: **Dave Anderson, Tim Fuller-Rowell, Jan Sojka**

The goals for this year's GIFT workshop were twofold. The first segment continued last year's very successful theme of presenting Kalman Filter Data Assimilation techniques—specifically concentrating on low and mid latitude ionospheric drivers.

Discussions included a.) The importance of getting the "first best guess" ionosphere right, b.) Techniques that can be used to infer drivers such as E×B drift, neutral atmosphere and neutral winds and c.) Current and future sensors.

› **Ludger Scherliess,** using a physics-based Kalman Filter approach, clearly demonstrated that care must be taken in depending solely on GPS/TEC observations to infer low-latitude E×B drifts. This is because TEC is an integrated ionospheric parameter and cannot distinguish between profiles when both N_{max} and profile shape are changing.

› An excellent presentation by **Adela Anghel** showed that daytime-averaged, vertical E×B drifts at low latitudes could be obtained by observing the equatorial anomaly crest separation (degrees) between 1800–2000 LT. She used post-sunset GUVI 1356 A disc observations to establish this relationship.

› A discussion of the use of Kalman Filter and 4D-VAR techniques was presented by **Xiaoqing Pi** to estimate low latitude drivers such as E×B drifts and trans-equatorial neutral winds.

› Finally, **Cliff Minter** presented a very thoughtful discussion of the Kalman Filter techniques needed to obtain information on neutral atmosphere parameters.

The second segment concentrated on low latitude ionospheric scintillation activity including a.) Nowcasting vs Forecasting scintillation activity, b.) Sensors and techniques and c.) Future capabilities.

› **Cesar Valladares** provided an excellent description of the latitude chain of ground-based GPS receivers in the South American (West coast) sector and how these receivers are capable of measuring both TEC values and scintillation activity and how they are related.

› This was followed by the introduction of a new Scintillation Forecasting technique being developed by **Space Environment Corp.,** Providence, Utah and called PROV_SCINT. The basis for the technique is the observation, night-to-night, of how rapidly the bottom-side of the F layer rises after sunset. If it is greater than 20 m/sec, then a forecast that S4 (UHF) will be greater than 0.5 is made.

› Finally, **Odile de la Beaujardièr**e gave an enthusiastic preview of the science issues that will be addressed when the C/NOFS (Communication/Navigation Outage Forecast System) satellite is launched into its low inclination orbit in January 2004.

All of the excellent presentations led to substantial audience debate and discussion. The workshop participants numbered about 60 people.

ISR Contributions to CEDAR Science Workshop

Convener: **Philip Erickson**

Attendance: perhaps 20

This short workshop had a primary objective of showcasing some of the ISR facility features to users and potential new users, with a particular focus on contributions to CEDAR science. Information from all four US funded IS facilities (Jicamarca, Arecibo, Millstone Hill, and Sondrestrom) was presented by **Jorge Chau, Sixto González, Phil Erickson,** and **Jeff Thayer.** Phil Erickson also presented a contribution by Tony van Eyken from the EISCAT facility.

With the first half of the workshop taken up by these overviews, the second half was spent in discussion with the audience on ways that users might interact with the science and technical staff at each facility. Several students were in the audience, and the discussion expanded to include interactions with the MADRIGAL database and use of some of its new features.

Your CEDAR Science Steering Committee Members

There are 17 members of the CEDAR Science Steering Committee (CSSC). Two are student representatives with 2-year overlapping terms (**Lars Dyrud** of Boston University and **Stanley Briczinski** of the Pennsylvania State University), and two are international representatives with 2-year overlapping terms (**Robert Vincent** of the University of Adelaide in Australia and **Don McEwen** of the University of Saskatchewan in Canada). We also have a GEM representative (**Joshua Semeter** of SRI International), and three ex-officio NSF representatives (**Richard Behnke, Robert Kerr,** and **Robert Robinson**). The CEDAR Workshop coordinator, **Barbara Emery** of HAO/NCAR, is often an ex-ex-officio participant, since a successful annual CEDAR Workshop is part of the goals of the CSSC.

Most CSSC members serve for 3 years, except for the chair (**Sixto González** of Arecibo Observatory), who remains on the CSSC longer in order to be chair for two years. The duties of the CSSC include steering the community. This can be through assistance with the process of getting AMISR, or through evaluations such as the 1997 CEDAR Phase III report *(http://cedarweb.hao.ucar.edu/docs/CEDAR.pdf)*. This year, part of the steering comes in the form of reports on the lidar community *(see article by Richard Collins)*. This was also the year of the evaluation of the incoherent scatter radars.

The members of the CSSC with their affiliations and e-mail addresses are listed at the end of every CEDAR Post. If you have any concerns or ideas for your CSSC, please contact any member.

Thanks to off-going members!

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University of Sheffield, UK
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Delores Knipp
US Air Force Academy
GEM liasion

Erhan Kudeki
University of Illinois

Pamela Loughmiller
Cornell University
student representative

Arthur Richmond
HAO/NCAR

Thanks to on-coming members!

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student representative

Richard Collins
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