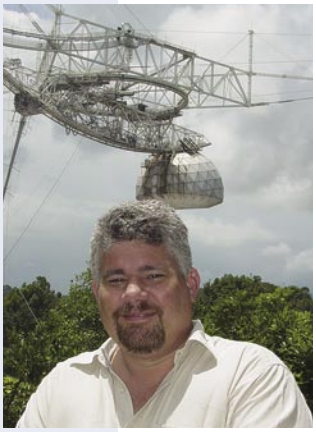
THE CEDAR POST

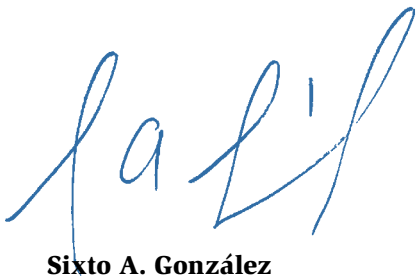
COUPLING, ENERGETICS AND DYNAMICS OF ATMOSPHERIC REGIONS

FROM THE CSSC CHAIR

I would like to begin by thanking Barbara Emery and all her staff who made the June 2004 workshop run so smoothly. The steering committee members report many positive comments on the new venue in Santa Fe and we are all looking forward to next summer when the CEDAR Meeting will be held jointly with the GEM Workshop.



This issue of the CEDAR Post contains workshop reports and some other news from this summer. Two thousand four has been a busy year for the CEDAR community with the completion of the upper atmosphere facilities panel review (led by Susan Avery), the Lidar community self-assessment report (led by Rich Collins), and a passive optics community instrumentation review (in progress). This coming year we will be busy getting ready and planning for AMISR and focusing on M-I coupling and other issues of common interest to the CEDAR and GEM communities. Finally, I want to recognize our new CSSC chairman-elect Jan Sojka. I look forward to working closely with him over the coming year.



Sixto A. González
Arecibo Observatory

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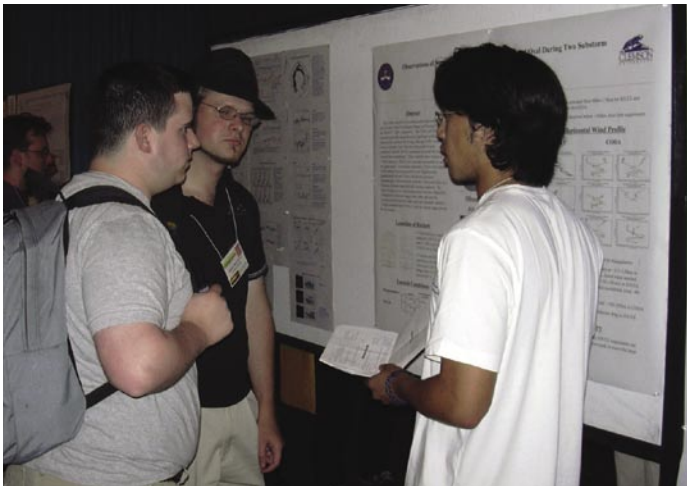
Young-Sil Kwak of Korea sits at the dining room table in one of the individually decorated Fort Marcy Suites rooms, about a quarter of which were 'challenged' in the number of beds available.

Kathryn Fisher and Louise Beierle behind the CEDAR registration desk.



Tianyu Zhan of Clemson University describes his poster to interested Clemson undergraduates Bailes Brown (left) and Andy Owens (middle).

Summary of the 2004 CEDAR Workshop

Eldorado Hotel, Santa Fe, New Mexico
27 June - 2 July 2004
Barbara Emery, HAO/NCAR

The CEDAR (Coupling, Energetics and Dynamics of Atmospheric Regions) Workshop for 2004 was held at the Eldorado Hotel in Santa Fe, New Mexico.

A total of 317 persons from 71 institutions, 17 outside the United States and Puerto Rico, attended the 2004 CEDAR Workshop. This year, 121 students and recent grads came from 26 universities and 5 research labs, including Canada (4), Japan (4), the United Kingdom (1), France (1), Korea (1), Brazil (1) and Columbia (1). The total attendance was down from 356 in 2003, with 12 fewer students and 19 fewer Colorado locals.

The Student Workshop on Sunday organized by the new CEDAR student representative Stanley Briczinski of the Pennsylvania State University looked at "Instrumentation – Gear for Your Thesis." There were 6 speakers, one of whom, Alexander Hassiotis, is a student from Penn State. He spoke on "LIDAR for Dummies." The Keynote Speaker was Ron Woodman, who gave a talk on "Incoherent and Coherent Scatter Radars: Jicamarca Examples," which was video-taped and is also on-line in .pdf form (click on 'Tutorials'). Stan will continue next year in his second year as student representative, joined by Carlos Martinis of Boston University.

The CEDAR Prize Lecture was given by Maura Hagan of the National Center for Atmospheric Research. She gave a good overview of 'Tidal Coupling in the Earth's Atmosphere'. The 4 tutorial speakers were Craig Heinselman of SRI International (AMISR), Chet Gardner of the University of Illinois (Lidar winds and temperatures), Dave Hysell of Cornell University ('AMISR Contributions to Equatorial Aeronomy'), and Paul Bernhardt of the Naval Research Laboratory (chemical release studies). All of these talks are available as .pdf files on the web (click on 'Tutorials') and are also on video tape. Please contact Barbara Emery (emery@ucar.edu, HAO/NCAR, PO Box 3000, Boulder CO 80307) if interested in obtaining hard copies and/or videos.

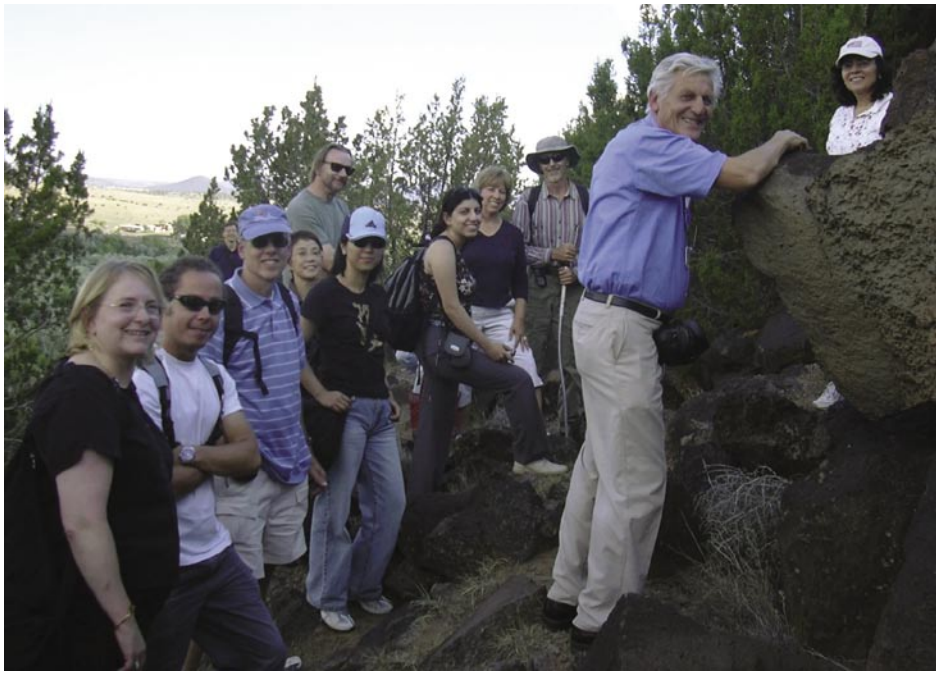
There were 25 workshops, which was the same number as last year, in spite of having 2 hours less of workshop time and combining several workshops together. The specific workshops are described elsewhere in this issue.

There were 6 CEDAR and related post-doc reports given by Rebecca Bishop of Clemson, James Boulter of SRI, Aimee Merkel of NCAR, Weilin Pan of SRI, Alok Taori of USU, and Paul Withers of BU. There were also about 15 programmatic talks during the plenary sessions, which were about 5 hours shorter than most years.

We enjoyed two late afternoon poster/reception sessions on Tuesday and Wednesday, where all posters were up the entire time. We had 83 posters presented on Tuesday and 50 on Wednesday, for a total of 133. This is a record number of posters, exceeding the number of 118 set last year. The poster lighting was a little low due to the presence of beautiful (but opaque) blue draperies that were hung on the walls and ceiling in preparation for the masked Opera Gala on Thursday. The lighting was better for the middle atmosphere topics presented on Wednesday!

We had 64 student posters under competition, and 14 other student posters for a record number of 78 student posters. The previous record was 64 student posters in 1994. Congratulations to our CEDAR students! There were two student winners in the poster competition, Ningyu Liu of the Pennsylvania State University and Melissa Meyer of the University of Washington. There were also three honorable mentions: Xiaohua Fang of the University of Michigan, Patrick Roddy of the University of Texas at Dallas, and Jing Tang of the University of Illinois. They all received prizes of books, and will get achievement certificates to hang on their walls!

There were many extra-curricular activities for the 2004 CEDAR Workshop. We took a 56-passenger bus from Fort Collins, Colorado to Santa Fe with 12 passengers coming down from Colorado. This bus was then used to take students to the student bowling social at Silva Lanes on Sunday evening, and was also used as transportation for the tours arranged for us and our families by Santa Fe Destinations. We had two tours offered: one to the Bradbury Science Museum at Los Alamos and to the ancient Pueblo ruins at Bandelier National Monument, and the second to La Cieneguilla Petroglyphs. The tours were well done and enjoyable, but except for Friday, were scheduled during workshops or poster sessions!



The Wednesday CEDAR petroglyph tour follows our leader, Dennis Slifer with the walking stick through La Cieneguilla.

Santa Fe Destinations also designed a petroglyph CEDAR T-shirt for us to commemorate the meeting. There are still 9 shirts left over (5 long sleeved, 4 short sleeved, most XL with one 2XL and one L). Please contact Barbara Emery (emery@ucar.edu) if interested in a shirt.

The joint 2005 CEDAR-GEM Workshop will take place at the Eldorado and the La Fonda Hotels in Santa Fe, New Mexico June 26 - July 1. A joint CEDAR-GEM committee put together by Josh Semeter, our CEDAR-GEM coordinator, will work on the science overlap, community activities, and logistics to have a great joint experience.

Student Workshop: Instrumentation Gear for Your Thesis

Conveners: **Stan Briczinski**, **Lars Dyrud**

The 2004 CEDAR student workshop, "Gear for Your Thesis," focused on introducing students to basic understanding of some of the tools used in the community. The morning talks focused on lidar and its applications to remote sensing.

› **Alex Hassiotis** *(Penn State)* provided an introductory talk, "Lidar for Dummies," covering the principles of how lidars work and what they can be used to measure.

› **Rich Collins** *(University of Alaska Fairbanks)* followed with "The CEDAR Lidar Report, Thoughts for Students," in which he explored possible research opportunities for students looking for thesis projects.

› The afternoon sessions began with **Jeff Baumgardner's** *(Boston University)* talk, "Design Considerations for Monochromatic Imagers and Imaging Spectrographs," where students were exposed to the thought processes involved in constructing optical imagers.

› **Jon Makela** *(NRL)* followed up with "Basic Imaging Techniques for Ionospheric Studies," in which he showed how all sky cameras impact upper atmosphere research. The last third of the workshop highlighted the role of radars in CEDAR.

› **Mary McCready** *(SRI)* gave an overview of all of the research opportunities available at Sondestrom in her talk, "Shop at the Sondestrom Facility—Quality Artic Gear for Your Thesis."

› Finally, the keynote talk was presented by **Ronald Woodman** *(Jicamarca)*. His talk, "Incoherent and Coherent Scatter Radars: Jicamarca examples," covered the basic techniques of coherent and incoherent scatter radars as well as how they have impacted atmospheric research.

Thanks to the speakers and everyone who attended, the 2004 student workshop was a rousing success!

CA1: Comparative Aeronomy on Earth and Mars

Conveners: **Michael Mendillo**, **Paul Withers**

A workshop entitled "Comparative Aeronomy on Earth and Mars" was held on Tuesday 27 July as part of the 2004 CEDAR Meeting in Sante Fe, New Mexico. Approximately 100 people attended. The aim of the workshop was to stimulate an interest in comparative aeronomy among scientists working in terrestrial aeronomy. Speakers were asked to describe some aspect of the aeronomy of Mars in comparison to the Earth's behavior. Some speakers and audience members also emphasized the benefits of comparisons that include Venus, a terrestrial planet whose aeronomy is understood better than that of Mars, or Jupiter and Saturn, gas giant planets whose atmospheres are dominated by hydrogen and helium and exhibit strikingly different behavior from Earth.

› **Michael Mendillo** *(Boston University)* began the workshop with an introduction, explaining how the atmospheres of Earth and Mars are both dominated by molecular, not atomic species, how both ionospheres are dominated by molecular ions that are produced by charge exchange between neutrals and photo-produced ions, how both ionospheres are double-peaked, and how both ionospheres have lower boundaries near 100 km altitude. The ionosphere, exobase, and ionopause regions on Mars span only a few hundred kilometres, one-tenth of their range on Earth.

› **Jim Murphy** *(New Mexico State University)* discussed thermospheric general circulation models (GCMs) for Earth and Mars. Several different Martian GCMs exist, all deriving from terrestrial GCMs. The many similarities between the atmospheres of Earth and Mars make GCMs more robust on Mars than on any other planet besides Earth. No ground-to-exosphere GCM exists for Mars yet, which makes the upper and lower boundary conditions of any GCM critically important and also impedes accurate modeling of vertically propagating waves and tides. Since there are no measurements of winds in the upper atmosphere of Mars, models play a key role in studies of atmospheric dynamics.

› **Monica Angelats i Coll** *(UCLA)* discussed tides and gravity waves on Earth and Mars. Mars has much more diurnal heating per unit atmospheric mass than Earth,

which generates strong migrating tides, topographic relief of over 20 km, which generates many other tidal modes and waves, and no ozone layer, which encourages vertical propagation of these disturbances. Consequently, tides and waves deliver large amounts of momentum and energy to the martian upper atmosphere and perturb it greatly.

› **Rod Heelis** *(UT Dallas)* discussed the measurements and observations necessary to form a comprehensive picture of the aeronomy of Mars. They are similar to those provided by the Dynamics Explorer mission for the Earth over 20 years ago. Suitable instruments, such as an ion-neutral mass spectrometer, a Fabry-Perot interferometer, a UV spectrometer, a retarding potential analyzer, and a Langmuir probe, have flown on many spacecraft and have a high technology readiness level. Heelis encouraged audience members to attend an August 2004 Mars Aeronomy Workshop, organized by NASA HQ, that will discuss specific opportunities for future spacecraft missions that study martian aeronomy (http://argyre.colorado.edu/life/aeronomy_workshop/).

› **Paul Withers** *(Boston University)* discussed how to start a research project involving martian aeronomy. All NASA spacecraft data from Mars is freely available at either http://pds.jpl.nasa.gov/ or http://nssdc.gsfc.nasa.gov/planetary/planets/marspage.html. These websites also have useful descriptions of past and future missions, instrumentation, and personnel. General circulation model results are available at either http://data.engin.umich.edu/tgcm_planets_archive/thermo.html or http://www-mars.lmd.jussieu.fr/mars/access.html. The most commonly used reference book is "Mars", published by the University of Arizona Press in 1992 and edited by Kieffer et al. $3M of funding for Mars-related research, including comparative aeronomy, is available from NASA's Mars Data Analysis Program each year.

› **Geoff Crowley** *(SWRI)* gave a brief presentation on the status of his Mars GCM, which is under development. Several members of the audience discussed comparative aeronomy research further with the workshop conveners during the remainder of the CEDAR meeting. We are hopeful that this workshop has catalyzed several new research projects in this area that will be reported at the next CEDAR meeting.

ISR1: Distributed Radio Instrumentation

Convener: **Frank D. Lind**

This workshop focused on current and future efforts to deploy and use radio and radar instrumentation networks for CEDAR related science. The purpose of the workshop was to provide a forum for discussing current efforts and insights in this regard. The workshop was attended by approximately 50 people. The first hour of the workshop was taken up by a series of four invited talks. The remaining hour was dedicated to more open discussions.

› The first speaker was **John Foster** *(MIT)* who discussed DASI : Distributed Arrays of Small Instruments. DASI is currently a project under development to enable the deployment of a wide range of instrumentation to provide wide spatial coverage of geospace using ground-based sensor networks. This would happen through a Major Research Equipment (MRE) proposal to NSF at some point in the future. John reported on the intent of DASI as well as a recent (June 2004) NRC workshop in Wood's Hole, MA where the science rationale of DASI was discussed. DASI will need from the start to be a community effort but there is great enthusiasm for the science potential particularly when these types of instruments are combined with assimilative modeling. John gave examples of the power of distributed arrays of small instruments using GPS TEC mapping examples for observations of Storm Enhanced Density regions of the American sector.

› The second speaker was **Ray Greenwald** *(JHU/APL)* who discussed the SuperDARN network. Ray provided an overview of the current SuperDARN deployment and planned expansions both in the north and southern hemispheres. Of particular note were efforts to provide new SuperDARN radar systems at mid-latitudes, which will provide coverage during geomagnetic events. Ray provided an extensive discussion of logistical issues associated with SuperDARN as well as the role of international collaborations in fielding a distributed radar system. Ray placed emphasis on the need to have uniform data standards and a formalized means of gathering and distributing data.

› The third speaker was **Brent Ledvina** *(Cornell University)* who discussed software radio GPS receivers. Brent described the efforts at Cornell to develop implementations of GPS receivers where the primary signal processing is all performed on general purpose computers. This enables easy reconfiguration of the receivers as new navigation signals become available (e.g. GPS L5, Galileo, etc.) and allows customization of the receiver to observation tasks such as high rate scintillation monitoring. Brent discussed the advantages of software radios the primary of which are their performance, flexibility, and lower cost. He also showed examples from his current software radio implementation for L1 GPS signals and discussed performance constraints.

› The fourth speaker was **Frank Lind** *(MIT)* who discussed the Intercepted Signals for Ionospheric Science (ISIS) array. The ISIS Array is a distributed instrument project that has received $500k USD in hardware funding from the DoD Defense University Instrumentation (DURIP) program. The ISIS project is a prototype coherent software radio network capable of operating as a flexible multi-role distributed radio science instrument. In particular, operational modes involving active and passive multistatic radar imaging, satellite beacon observation of TEC and scintillation, and radio intercept and TDOA applications will be supported over a wide range of operating frequencies (0.5 to 2000 MHz). The system will be constructed of a series of MIDAS-Mobile nodes (Millstone Data Acquisition System), which can coherently capture wide bandwidths of RF signals from a variety of antennas. The array will be capable of applying high performance supercomputing to the real time and batch processing requirements of a variety of experiments. Initial Deployment of the ISIS Array is expected to happen in summer 2005 with five nodes in the Northeast U.S. and two nodes in the Northwest.

Additional questions and discussions followed the main presentations and there was considerable enthusiasm for the above topics. After the main presentations the open discussion section of the workshop allowed short presentations by other interested parties.

› **Bill Wright** *(NOAA)* discussed progress on the development of a new Dynasonde design using digital receivers and software radio approaches. Some discussion also occurred on the role of distributed instruments in supporting AMISR. In particular, the logistical challenges were discussed along with the potential utility of orienting AMISR to take advantage of the expanded observational capabilities currently being deployed in Canada. At the end of the workshop the audience and participants were asked if this type of workshop should be organized again next year. It was clearly indicated that additional workshops on this topic should be organized in the future at CEDAR and other meetings.

ISR2: Low- and Mid-Latitude Aeronomy and Stormtime Disturbance

Conveners: **Dave Hysell, Michael Sulzer, Hyosub Kil, Jonathan Makela, Mihail Codrescu**

ISR2, Part I:
Aeronomy Research at the Upper Atmospheric Facilities

This workshop concerned aeronomy research at low and mid latitudes conducted at Arecibo and Jicamarca using the incoherent scatter radars and the adjoining instrument clusters. The workshop differed from those held in past years in two major respects. First, the conveners combined the two facilities into a single workshop and solicited presentations identifying research problems that can best be addressed using both facilities. Second, they held discussions pertaining to facility news and programmatics to a minimum, maintaining a focus on emerging problems in low latitude aeronomy and experiments designed to pursue them.

A number of joint investigations are already taking place at Jicamarca and Arecibo, including studies of the topside composition. **Sixto González** pointed out that such studies have been underway at Arecibo for many years and have progressed to the point of validating physics-based models, which have only recently been able to reproduce the high helium ion abundances seen at mid-latitudes at night during solar minimum. **Fabiano Rodrigues** presented new topside composition results from Jicamarca, where a topside observing program has just begun. All agreed that current empirical models of the

topside are inadequate and potentially misleading (e.g. for TEC estimates). Another topic of common interest is meteor head echoes, which are being studied at both facilities by **Diego Janches.** He pointed out the significance of being able to determine the bearing of micrometeorites at Jicamarca using interferometry in estimating total flux rates.

Some differences in the research programs at Arecibo and Jicamarca necessarily arise from differences in the capabilities of the radars. At Arecibo, observations of the photoelectron-enhanced plasma line make it possible to distinguish between molecular ions in the bottomside **(Néstor Aponte)** and to observe gravity-wave-induced plasma density fluctuations with very high spatial and temporal resolution **(Frank Djuth)**. At Jicamarca, the ability to observe coherent backscatter from field-aligned irregularities facilitates investigations of gradient drift and Farley Buneman instabilities in the E region **(Esayas Shume, Meers Oppenheim)** as well as of anomalous 150 kilometer echoes from the valley region **(Jorge Chau).** Plasma instabilities and field aligned irregularities represent interesting physics in their own right but also permit certain radar diagnostics of ionospheric electric fields, plasma densities, and neutral winds that would otherwise be impossible at Jicamarca.

A surprising aspect of the workshop was the emergence of gravity waves as the dominant source of debate. Gravity waves are observed only indirectly through their influence on the plasma dynamics and structure. In addition to the Arecibo plasma line experiments, gravity waves are clearly evident in the vector plasma drift profiles measured routinely at Jicamarca, demonstrating their ability to polarize the plasma. **Mike Nicolls** discussed a spread F event observed at both Arecibo and Jicamarca that was triggered by neutral forcing. **Dave Fritts** then outlined a new experiment that will look for evidence that gravity waves generated by convective storms in the troposphere actually seed equatorial spread F events over Brazil. Such a seeding mechanism, if it could be demonstrated, would represent an important space weather effect. Another space weather effect studied at Arecibo and Jicamarca is the equatorward propagation of storm-time TEC perturbations evident in data from the South American GPS chain as demonstrated by **César Valladares.**

Optical instrumentation is an integral part of aeronomy research at the two low-latitude facilities. **Michael Faivre** presented Fabry Perot interferometer data showing clear signatures of the Midnight Temperature Maximum (MTM) observed over Arecibo and Jicamarca. Modeling this phenomenon has been challenging but provides unique insight into the tidal forcing that must be present in the lower thermosphere. **Jonathan Friedman** later discussed the collocation of sporadic layers and atomic layers observed over Arecibo. The assembled group looked forward to new optical instrumentation scheduled for deployment in Puerto Rico and South America.

ISR2, Part II:
Storm-time Ionospheric Disturbance in the Low Latitudes

The second part of the workshop focused on ionospheric disturbances in the low-latitude region during magnetic storms. The main drivers of the ionospheric disturbance in the low-latitude region are storm-time electric fields, neutral winds, and thermospheric composition disturbance (TCD). The goal of this workshop was to put together the observations and model simulations to distinguish their contributions to the ionospheric disturbance. The presentations in this workshop demonstrated the importance of storm-induced electric fields as drivers of ionospheric disturbances in the low-latitude region. They modify the location and strength of the EIA, create a deep equatorial ionization trough, suppress or promote the equatorial bubble activity depending on when they occur, and also affect the equatorward expansion of the TCD. The TCD is known as a primarily plasma depletion mechanism in the high- and middle-latitudes during storm time but its effect has been ignored in the low-latitude region. This may be the first CEDAR workshop that provided an opportunity for a full discussion of the TCD effect on the low-latitude ionosphere. The model simulations and observations provided clear evidence of the expansion of the TCD from the high latitudes to equatorial region and the equatorial plasma depletions by the TCD. This workshop stimulated the study of the TCD contribution to storm-time effects in the low-latitude ionosphere. The important questions raised in this workshop are (1) Could we distinguish the effects of the direct penetration

and dynamo electric fields? (2) What are the suppression and promotion mechanisms of the bubble activity during storm time? (3) Could the TCD be the plasma depletion mechanism in the equatorial region? This workshop suggested some clues to these questions and also motivated a new approach to the phenomena in the low-latitude ionosphere. The future challenges are to provide solid evidence that supports the proposed new ideas.

Below is the summary of the presentations with a complete list of the speakers and topics:

› **Bela Fejer** gave an excellent overview of the penetration and dynamo electric fields that are the main drivers of ionospheric disturbances during storm times.

› **Jonathan Makela** presented observations of the change in zonal plasma drift velocity and F-layer height during storm time from ground-based optical measurements and discussed the effects of the storm-time electric field on equatorial plasma bubble activity.

› **Naomi Maruyama** conducted Coupled Thermosphere-Ionosphere-Plasmasphere-Electrodynamics (CTIPe) model simulations and showed that the direct penetration electric field can modify the ionospheric dynamo by changing the conductivity and neutral wind.

› **Sid Henderson** investigated the morphology of the nighttime Equatorial Ionization Anomaly (EIA) by using OI 135.6-nm disk-scan data from TIMED/GUVI and showed that the strength of storm-time ionospheric disturbances is variable with season and longitude.

› **Trevor Garner** investigated the location and strength of the EIA during the storm of October 30-31, 2003 by using the Ionospheric Data Assimilation Three Dimensional (IDA3D) Algorithm and showed the formation of deeper equatorial ionization trough and greater separation of the EIA than predicted by climatological models.

› **Geoff Crowley** gave a tutorial on ionosphere-thermosphere coupling effects and also presented model simulation results that showed the suppression of the daytime oxygen density in the low-latitude region during big storms.

› **Yongliang Zhang** investigated thermospheric composition disturbance (TCD) by using optical measurements from the TIMED/GUVI and IMAGE/SI-13 instruments and showed the expansion of the TCD from the high latitudes to the equatorial region.

› **Pallamraju Duggirala** presented observations of large enhancements in OI 630.0-nm emissions during the daytime in Chile during the magnetic storm of November 6, 2001 and attributed this phenomenon to the enhancement of neutral density produced by the equatorward propagation of neutrals.

› **Hyosub Kil** investigated the formation of large equatorial plasma depletions during big magnetic storms and proposed that they are produced by the enhanced chemical plasma loss in the bubbles caused by the TCD.

ISR3: Mid-Latitude Plasma Structuring

Conveners: **Mike Ruohoniemi, Ray Greenwald, John Foster**

The first workshop on Mid-Latitude Plasma Structuring (MLPS) was held on Thursday afternoon in Anasazi South. About 50 people attended. The conveners were Mike Ruohoniemi and Ray Greenwald of JHU/APL and John Foster of Millstone Hill/Haystack Observatory. This tutorial workshop introduced the electrodynamics of the mid-latitude ionosphere as a specific study topic for CEDAR. Recent work has turned up exciting results on the occurrence of irregularities, intense electric fields, and the penetration of auroral effects. Observations with GPS are giving dramatic views of the structuring and transport of ionospheric plasma on global scales. Concern about the societal impact of ionospheric disturbance at mid-latitudes is giving added impetus to this research. Moreover, the characterization and understanding of variability in the mid-latitude ionosphere has been recognized as a primary objective of the upcoming NASA/LWS Ionosphere-Thermosphere Storm Probes mission. The workshop was motivated by a desire to focus the attention of the CEDAR community on these developments and to identify promising directions for research and collaboration.

› The invited speakers included **Bob Robinson** *(NSF)* and **John Foster,** who reviewed the range of ionospheric effects at mid-latitudes. These presentations related the perturbations to the penetration of high-latitude sources and to the dynamics of the plasmasphere.

› **Jan Sojka** *(USU)* described the inadequacy of the current modeling efforts to account for the impressive TEC perturbations seen in the GPS observations and suggested that elucidation of the critical physics in the mid-latitude region will require extending the observations and modeling to the highest latitudes.

› **Dave Hysell** *(Cornell)* showed new results on the structuring of sporadic E layers and the sources of small-scale irregularities in plasma instabilities.

› **Sundanda Basu** *(Boston University)* spoke to the impact of auroral disturbance in causing scintillations and GPS effects during magnetospheric storms.

› **Larry Paxton** *(JHU/APL)* presented results of effects in neutral winds and densities seen by satellite. During the brief presentation, **Mike Ruohoniemi** described a project to extend Super-DARN capabilities to mid-latitudes with the construction of an HF radar at Wallops Island.

› **Nick Zabotin** *(NOAA)* interpreted dynasonde observations of small-scale irregularities in terms of plasma instabilities.

Many instructive comments were received from the audience in the course of the presentations. A consensus emerged that the variety of new results and the prospects for further discoveries points to a need to reprise MLPS at future CEDAR meetings. The 2005 meeting at Santa Fe would be particularly apt as it will be possible to engage GEM researchers in an expanded discussion of the solar wind and magnetospheric drivers of mid-latitude disturbance. Accordingly, we will propose to coordinate a session of MLPS next year with the GEM M-I coupling campaign.

ISR4: High-Latitude Plasma Structures Working Group

Conveners: **Jan Sojka, César Valladares, Lie Zhu**

The HLPS workshop was held on Monday, 28 June 2004 in the Anasazi room from 1:30 to 3:30. The workshop had a registered attendance of 40. This workshop was held prior to the Polar Aeronomy workshop, which highlighted science pursuits for the new AMISRs. Our HLPS workshop similarly directed discussions and presentations towards the future AMISR capabilities. One question was open throughout the session, namely, what were the science rationales for pointing the Resolute Bay AMISR bores in specific directions. This question is still open and input is being sought, if you have suggestions please e-mail them to us (Sojka, Valladares, and Zhu) or to the SRI AMISR team (Heinselman and Doe).

Five formal and three informal presentations were made. The working group had extended discussions on several topics that were generated by these presentations. The need for a systems level science approach in addressing science questions was voiced by all speakers. In the HLPS context, system level science means using all available observational techniques to complement AMISR observations.

› **Marc Hairston** began the session with a presentation of how DMSP satellites provide unique topside plasma observations for the 30-day HLPS October-November 2002 campaign. His focus was on how to present a month-long data set from up to four satellites over the polar regions. To help simplify this task only orbits that passed over (near) the Svalbard EISCAT ISR were shown grouped into an orbit pass and day of campaign color plot of specific observed parameters (Ni, Ti, Te, Vx, Vy, Vz, and Mi).

› **Jan Sojka** showed a few transparencies of the USU Time Dependent Ionospheric Model simulations for the same campaign, for the DMSP Ni, in the identical format. From the extensive discussions it was clear that this first attempt at reducing a thirty-day database in order to compare climatology and weather is perhaps more confusing than helpful. This is an open question for the HLPS team, how do we represent 30 days in a way that is easy to exchange and easy to read?

› **Gary Bust** *(University of Texas at Austin)* presented results from tomographic reconstructions of the polar cap F-region using TEC observations as input to a 4D-var model. His results were compared with EISCAT-Svalbard ISR data showing excellent agreement with F-region patches as they drift into the ISR field-of-view. AMISR at Resolute Bay would be particularly relevant for these studies given its central polar cap location and high spatial-temporal resolution. Parvez Guzdar presented modeling work of polar cap plasma instabilities that were 3-D, as well as whose boundary conditions evolved in time. This work is a theoretical prediction that the AMISR at Resolute Bay will have both adequate spatial and temporal resolution to test.

› **Ray Greenwald** *(John Hopkins University)* presented a few viewgraphs to provide evidence for how rapidly the polar cap convection electric field can change; from polar cap potential drops of 50Kv to 120Kv in 8 minutes.

› **César Valladares** *(Boston College)* presented results and questions for AMISR to address that pertained to polar cap arcs. These results again showed that the cutting edge of observations need to focus on resolving scales less than a 100km associated with arc structures that are non-stationary.

The session ended on a presentation by Rick Doe on AMISR followed by a discussion of AMISR and HLPS science. Michael Ruohoniemi presented an overview of AMISR and SuperDARN coverage giving suggestions on possible AMISR face bore directions. Ray Greenwald pointed out that one direction for a face bore sight direction is towards Manitoba. In this direction the AMISR observations would be made through a region of Canada that is heavily instrumented. These complementary observations would be an ideal 'systems level' attack on science questions. However, Roger Smith was concerned that the AMISR coverage was at its lowest elevations, which means that the ISR ray paths are crossing plasma structures and hence not resolving them. From the earlier HLPS presentations much of the AMISR work will be to emphasize overhead and along the near vertical field lines so as to get very high spatial resolution across field lines. Hence, these studies would not emphasize low elevation capability.

ISR5: Polar Aeronomy: Current Initiatives and Future Plans

Conveners: **Josh Semeter, Craig Heinselman, Phil Erickson**

The goal of the workshop was to identify and discuss current research initiatives in the field of Polar Aeronomy, with an emphasis on how the upcoming deployment of the Advanced Modular Incoherent Scatter Radar (AMISR) at Poker Flat, Alaska and Resolute Bay, Canada can advance these topics. The AMISR project constitutes a decisive long-term commitment by NSF to CEDAR science. Each AMISR deployment will serve as the centerpiece of an upper atmospheric facility (UAF), embodying collaborative optical and radar instrumentation from a diverse set of investigators. As such, the use of AMISR with other diagnostics constituted a thematic focus of the workshop. The workshop consisted of a series of speakers each representing a particular scientific theme. Background information on AMISR and its capabilities were given in the preceding tutorial talk by Craig Heinselman (http://cedarweb.hao.ucar.edu/workshop/tutorials/2004/heinselman04.pdf).

› The workshop was introduced by AMISR PI **John Kelly** *(SRI)*. Kelly stressed that community involvement is critical to the success of the AMISR project. The community also includes international researchers. Canadian involvement is particularly important for a successful program at Resolute Bay.

› The first science topic concerned the formation of thin layers in the ionospheric E-region, presented by **Craig Heinselman** *(SRI)*. As an example, Heinselman presented measurements of a sporadic E layer collected using the Sondrestrom ISR. The measurements showed the bifurcation of an advecting sporadic E structure. The evolution of such structures cannot be adequately characterized from these data because of the time required to obtain the measurements. He noted that the cause of the horizontal tilt in the layer is also not well understood. Local interactions among sporadic E layers, auroral ionization (measured using optics and radar), and sporadic neutral atom structures (detected with lidars) have been proposed, but concrete observational evidence is still

lacking. The AMISR facility will be able to remove much of the spatial/temporal ambiguities limiting observational studies of thin layers.

› **Phil Erickson** *(MIT-Haystack)* then discussed large scale magnetosphere-ionosphere coupling, primarily in the sub-auroral region. He focused on UHF coherent backscatter as a means of estimating E-field strength in the auroral electrojets and sub-auroral polarization streams (SAPS). In one particular storm event (October 30, 2003), he noted that the poleward edge of a SAPS was observed in Sondrestrom elevation scans, highlighting the utility of AMISR to fill in the global perspective of SAPS morphology and evolution. Another unique strength of AMISR is its versatility in configuration. Phil proposed that a configuration involving multiple smaller radars could be used in an interferometric mode to estimate electric field strength over small scales.

› Collaborations between AMISR and both SuperDARN and PolarDARN were discussed by **Bill Bristow** *(Univ. of Alaska)*. He noted that combined measurements of the convection velocity field with these complementary diagnostics will allow us to better understand ionospheric variability at multiple scales, and its influence on magnetosphere-ionosphere coupling. For example, it is still not known how fast the convection pattern responds to magnetospheric forcing, or how large the scale-dependent variability within the convection pattern is.

› The topic of Polar Mesospheric Summer Echoes (PMSEs) was discussed by **Mike Kelley** *(Cornell)*. Phased array ISR will allow for an improved characterization of the spatial structure of PMSEs. Kelly noted, however, that backscatter signal strength has a strong k-vector dependence, and argued that it will likely require a full AMISR face to detect PMSEs with reasonable SNR.

› **Roger Smith** discussed AMISR contributions to the study of neutral wind effects on the dissipation of electromagnetic energy from the magnetosphere (on behalf of Mark Conde, both at Univ. of Alaska). He presented evidence from the HEX and JOULE rocket campaigns showing large gradients in zonal wind in the vicinity of auroral precipitation. Such neutral wind dynamics can have a significant effect on electrodynamic coupling to the magnetospheric source. Smith also highlighted general contributions that AMISR will make as a supporting diagnostic for Poker Flat rocket experiments.

› **Eric Donovan** *(Univ. of Calgary)* discussed potential collaborative science between AMISR and the THEMIS satellite mission. As part of the THEMIS mission, a network of ground-based auroral cameras is being constructed and deployed across central Canada, providing a global-scale composite image of the auroral zone. Donovan argued that in order to optimally support THEMIS, at least one of the two Resolute Bay AMISR faces should be pointed southward into the Canadian camera array. Among the science topics that would be facilitated by such a configuration is the correlation of specific auroral forms with the transport of magnetic flux across an open/closed field line boundary.

› **Josh Semeter** *(SRI)* discussed the use of conjugate measurements by AMISR and space-borne sensors in the study of small-scale MI coupling. He noted that electrons accelerated by interactions with Alfvén waves near the polar cap boundary produce a particularly high degree of structure in the ionosphere, leading to some of the largest conductivity gradients at any latitude. Because of the intense filamentary currents carried by these Alfvén, these conductivity gradients can lead to polarization electric fields, which, in turn, affect MI coupling via feedback. In addition to providing high resolution measurements of ionospheric structure, AMISR will be able to track and characterize small-scale variability in electric field patterns around active auroral forms.

Although this set of topics does not constitute a comprehensive review of activity in polar aeronomy that will be addressed with AMISR, the results of the workshop set the stage for a more focused discussion anticipated at the 2005 joint GEM/CEDAR workshop. By that time, deployment and testing of the Poker flat AMISR face will have been completed. The two AMISR faces at Resolute Bay will be in place in 2006.

ISR6: Scheduling the Upper Atmospheric Facilities for World Day Coordinated Experiments

Convenor: **Wesley E. Swartz**

Coordinated experiments (called "World Days") at the Upper Atmospheric Facilities (UAFs) are scheduled each year under the auspices of the URSI Incoherent Scatter Working Group (ISWG). Other ground-based and space-based instrument clusters are also encouraged to take data on these days and contribute to the scientific studies. This year the CEDAR meeting provided a lively forum of about 40 participants who shared ideas for the World Day experiments for the 2005 calendar year. The resulting draft for a very ambitious year can be found at http://people.ece.cornell.edu/wes/URSI_ISWG/2005WDschedule.htm. This link also includes descriptions of the objectives of the various experiments.

A highlight of next year's schedule is a 30-day run, a "World Month", planned for the month of September. Although it is not expected that all the UAFs will run the full 30 days, both Millstone Hill and EISCAT Svalbard have already demonstrated the capability for continuous operations lasting this long. Also Jicamarca often makes very long runs, albeit usually in one of their lower power modes. Arecibo is likely to contribute to about 10 of the 30 days, either in two groups of 5 days or all in sequence. Discussions are continuing as to just what operational mode is optimum for each UAF.

We were reminded that our CEDAR modelers like to have three or more days in sequence for the best comparison/validation schemes. The groups of 3 to 5 day runs, as well as the World Month, should produce excellent data sets to meet these needs.

The data collected during World Days are readily available in the CEDAR database and/or through other online databases. Those interested in storm time effects should take a look at the World Day data for 2004 April 4 in which Millstone Hill recorded factors of 2 to 3 increases in the F-region electron densities. Interested parties should get in touch with the contact people listed for the appropriate World Day period type.

Other useful information (including the current and several past years' schedules) can be found on the index page at http://people.ece.cornell.edu/wes/URSI_ISWG.

ISR7: Meteors and the Upper Atmosphere

Conveners: **Lars Dyrud**, **Diego Janches**

We held a short presentation style workshop, with the following list of speakers, **Joe Grebowsky, Bill Bristow, James Boulter, Diego Janches, Lars Dyrud, Meers Oppenheim, Patrick Roddy, John Sahr,** and **Stan Briczinski.** The speakers and the topics discussed reflected the multi-disciplinary nature of this field. Topics included the meteor deposition of metal layers, and whether meteor ablation or subsequent transport is responsible for altitude stratification of species such as Mg and Fe. Subjects as varied as laboratory experiments of chemistry of meteoric dust, modeling of long duration meteor trails, and new observations from SuperDarn, South Pole, Arecibo, and passive radar near Seattle, all demonstrated the growing interest by the community in the effects and understanding of meteors and the mesopause. Finally, the convenors, Diego Janches and Lars Dyrud would like to thank everyone that took part and attended this year's workshop.

LDS1: Contributions to the Climatology of the Upper Atmosphere by Optical Techniques Associated with the Upper Atmosphere Facilities

Convener: **Rick Niciejewski**, **John Noto**

Fifty people attended the "Contributions to the climatology of the upper atmosphere by optical techniques associated with the Upper Atmosphere Facilities" workshop Thursday afternoon, July 1, 2004. This enthusiastic response resulted in the workshop extending from 3:45 to 6:45 pm.

The workshop goals focused on climatological studies related to long-term synoptic neutral wind and temperature

observations. Specifically, studies relating to long-term characterization of the climatology of the upper atmosphere (Global Change/Space Weather) were presented as well as relevant modeling studies. At the 2003 CEDAR meeting, related workshops included "The Fabry-Perot Interferometer Workshop" chaired by John Meriwether, Jr., and the "Topside Workshop" led by John Noto. These workshops described recent advances in technology and optical observations of exospheric parameters, respectively. The 2004 Climatology Workshop built upon the tradition of observing state variables with optical interferometers and the science problems that can be addressed by these measurements.

The Upper Atmosphere Facilities, the infrastructure at Kitt Peak in Arizona and at the EISCAT facilities in Europe provide a convenient platform for optical aeronomy and synoptic measurements. New findings related to upper atmosphere climatology were presented from all of these sites describing i) solar cycle dependences on neutral winds at high and middle latitudes, ii) solar cycle dependences on neutral hydrogen abundance in the exosphere, and iii) hot neutral helium abundance in the exosphere. Specifically, several talks were presented that showed the need for collocated optical and radar climatological measurements describing both the neutral thermosphere and the F-region ionosphere. A new emphasis for empirical modeling towards predicting thermodynamics in the upper thermosphere during magnetic storms was discussed. Attempts at predicting fine spatial details in neutral wind morphology and their associated difficulties were presented. The climatological description of the neutral atmosphere, made possible by optical measurements from a chain of observatories, was also discussed, including the creation of a small South American chain involving Fabry Perot interferometers from Clemson and Scientific Solutions.

A rousing discussion resulted from **Bob Kerr's** talk on the NSF perspective on passive optical observations. Discussions began with the question of whether the Upper Atmospheric Facilities (UAF) directorate should be required to fund optical observations. This extended to how the optical community feels about facility optics in general and its funding model, and what we can do as a community to further optical observations. Mention was made of improving capabilities at the existing observatories by upgrading extant instrumentation with class one detectors such as CCD cameras and adding spectrometers. The stability of a long-term synoptic observation strategy is dependent upon repeated measurements with a group of standard and fixed experiments. The manpower and equipment resources that have provided these measurements have reached a stage where serious component failures or retirements are a real concern. The future challenges that were identified for the community are to i) articulate the need for long-term climatological observations, ii) to consolidate resources into a common consortium effort, and iii) to maintain and upgrade the current instrumentation base. Work proceeding towards these goals will be embodied in the forthcoming Passive Optics Workshop Report to the CEDAR Science Steering Committee in November 2004.

LDS2: Applications for GPS in Multi-Instrument Investigations

Conveners: **Anthea Coster**, **Patricia Doherty**

The goal of this workshop was to bring the community together to design a series of collaborative experiments using GPS data. Specifically with the Advanced Modular Incoherent Scatter Radar (AMISR) coming on line, we have an opportunity to collect background information in the dynamic polar region. There also exist opportunities to plan investigations combining GPS data with measurements from the Communication/Navigation Outage Forecast System (C/NOFS) satellite instrumentation. In this workshop, we attempted to identify and discuss the scientific areas such as the irregularities and spatial gradients of the equatorial anomaly and sub-auroral trough region that may be investigated with the combination of various types of instruments.

The workshop began with introductions demonstrating the purpose and capabilities of AMISR and C/NOFS. These presentations were followed with a description of GPS capabilities for ionospheric characterization and how GPS has been combined with other instruments. These presentations generated much discussion on the upcoming instrumentation and on the overall usefulness of GPS in development and experimentation.

› **Rick Doe** *(SRI)* made the first presentation on the Advanced Modular Incoherent Scatter Radar (AMISR). AMISR will be constructed in two stages over the next four years. The first face will be constructed in Poker Flat, Alaska. A subsection of AMISR, an eight-panel radar, will be deployed at the Jicamarca Radio Observatory (JRO) in 2004. The remaining two faces will be built in Resolute Bay, Nunavut, Canada. Subsequent locations will be determined by a scientific advisory panel.

The AMISR faces will initially be pointed to sense the polar cap and auroral regions with some possibility of pointing equatorward to cover sub-auroral areas. In its high latitude position, AMISR is capable of monitoring the global polar convection pattern, polar cap arc, electrodynamics and F-region patch structure and evolution. As was pointed out by Phil Erickson, the merging of GPS observations of storm enhanced density (SED) and the tongue of ionization with AMISR observations will help explain and interpret some of the complex phenomena observed in the polar ionosphere.

› **Odile de la Beaujardière** *(Air Force Research Lab)* made the second formal presentation on C/NOFS. Odile initiated the discussion with a summary of the C/NOFS mission to provide continuous global scintillation forecasts of communication and navigation outages. The mission will also enable an improved understanding of the equatorial ionosphere and the scintillation triggers and inhibitors. The C/NOFS satellite will be equipped with various instruments that include a GPS receiver. Odile discussed efforts to complement the C/NOFS efforts with campaign data and data from various instruments. These instruments will include ground-based TEC and scintillation measurements made from various GPS receivers. In particular, a network of TEC and scintillation receivers located along the west coast of South America have already been used to validate the background models of C/NOFS and will be an integral part of validation of the impending measurements.

› **Anthony Mannucci** *(JPL Caltech)* made the last invited presentation, which focused on the capabilities of GPS in ionospheric characterization. Tony provided a brief review of what GPS measures—both on the ground and in space. In many ways GPS data are complementary to other instruments. Tony showed examples of how GPS TEC measurements in the equatorial region were complementary to observations from the Julia radar at Jicamarca, how GPS TEC measurements were complementary to optical measurements in Puerto Rico and Hawaii, and how GPS scintillation measurements tracked magnetometer readings at the Bear Lake Observatory. GPS mapping techniques have provided a new visualization tool to observe the complex dynamics of storm-time TEC. GPS TEC measurements and their proxies are being successfully incorporated into next generation data assimilation models for the ionosphere. GPS has the advantage that it is continuously available, it can provide global and regional coverage, and it is sensitive to both small and large-scale plasma structure. Integrating GPS measurements into multi-instrument campaigns will lead to increased understanding of the complex physical processes in the high-, mid-, and low-latitude ionosphere.

Much interest was generated from the workshop participants during these presentations. There were numerous comments and questions that revealed a general interest in elevating GPS for scientific investigations and collaborations with other instruments.

The formal presentations were followed by short presentations:

› **Gary Bust** discussed an open source GPS tool kit that facilitates processing raw GPS data to obtain ionospheric electron content.

› **Larisa Goncharenko** illustrated the usefulness of combining GPS with ISR data.

› **Jon Makela** talked about the capability to measure the worldwide ionosphere by combining GPS with imagers.

› **John Foster** made recommendations for using GPS in the Global Plasma Structures Radar Experiment, a planned 2005 ISR Campaign day.

› **Tim Fuller-Rowell** addressed the modeling aspect by showing the benefits of using multi-instruments, including GPS, in regional ionospheric modeling.

› **Brent Ledvina** described a promising technique to estimate the ionospheric scattering altitude from GPS measurements made from three receivers.

› **J.Y. Liu** showed how GPS signatures have great potential to detect earthquake epicenters.

Nearly 100 people attended this workshop. Although we did not realize the goal of designing collaborative experiments using multi-instruments, we were successful in initiating communication between various groups and in generating interest in these possibilities among student participants. Handouts were provided that described the basic GPS equations, information on processing techniques and problems, directions to data sources and relevant references. Overall, the conveners of this workshop were encouraged by the level of participation and interest in this topic.

LDS3: Effects of Geomagnetic Storms in the Lower Thermosphere and Mesosphere Workshop

Convener: **Larisa Goncharenko**

The workshop was intended as opportunity to review recent progress and outline future efforts in our understanding of effects of geomagnetic storms in the lower thermosphere and mesosphere. The workshop concentrated on changes in neutral winds, temperature and composition below ~150 km.

Speakers and topics:

- **J. Emmert,** Storm-Induced Disturbance Winds in the Lower Thermosphere: Recent Experimental Results and Future Challenges
- **T. Fuller-Rowell,** What Do Physical Models Predict for Storm-time Changes in the Dynamics of the Lower Thermosphere?
- **G. Lu et al.,** The Global Ionospheric and Magnetospheric Response to the October 2003 Geomagnetic Storm: Observations and Initial TIME-GCM Results (presented by M. Hagan)
- **R. Niciejewsky,** Neutral Wind Measurements From Orbit of the MLT Altitude Range During Recent Geomagnetic Storms
- **Q. Wu,** TIDI Neutral Wind Results During Recent Storm Events
- **L. Goncharenko,** Studies of Storm-time Variations in Lower Thermosphere Dynamics with Millstone Hill IS Radar
- **L. Paxton,** Storm Time Dynamics From Guvi Studies
- **M. Ruohoniemi,** Mesospheric Winds From SuperDARN Radar

The presented work reveals general agreement between predicted and observed storm-related perturbations. The current understanding of the processes can be summarized as follows:

- Storm effects penetrate down to at least 100 km at all latitudes.
- A major source of mid- and high- latitude disturbance wind is expanded/enhanced ionospheric convection. It drives:
  - ➜ Zonal wind—eastward in the dawn sector, westward in the dusk sector.
  - ➜ Meridional wind—equatorward in the dawn sector, poleward in the dusk sector (due to Pedersen effect and ion drag).
- Direction of meridional wind depends on superposition of many forces (pressure gradients, ion drag, Coriolis) and can be highly variable.
- Average disturbance winds maximize near 130-150 km, and diminish sharply below 120 km.
- During very large storms, wind magnitudes in the lower thermosphere at mid-latitudes can increase by as much as 700 m/s.
- Response/saturation times are 0–9/12–24 hours, and do not change much with height above 110-120 km.

Special attention at the workshop was given to October-November 2003 Superstorms, with following highlights:

- TIDI-detected ~50 m/s eastward disturbance wind at 90–110 km at southern high latitudes and eastward wind shift from post-noon to pre-noon at low latitudes.
- GUVI observed deep depletions in O/N_2 penetrating to 0-15° lat with areas of increase in O/N_2.
- Millstone Hill ISR observed increase in E-region ion temperature up to 1000-1300 K (factor of 2-3) and increase in electron density up to $2.5–5x10^{11}$ m^{-3} (> factor of 5).
- TIMEGCM (G. Lu, M. Hagan) & TIMEGCM/ASPEN (G. Crowley) model runs have been generated. Interested parties are invited to collaborate.

The workshop participants identified several future challenges:

- To collect more data, especially in the night-time lower thermosphere, which is not provided by current experimental techniques.
- To verify data reduction, assumptions and techniques for cases of major storms.
- To separate storm-related disturbances from day-to-day variability (in both observations and models).

Finally, the workshop included discussion of types of data available currently and in the future. It was noted that data provided by the instruments on the TIMED satellite have an important role for our understanding of storm-related changes in the MLT region. Among ground-based instruments, observations from the AMISR system and mesospheric winds from SuperDARN radars present new and exciting data resources.

LDS4: Superstorms: Observations, Analysis and Modeling of Large Geomagnetic Disturbances

Conveners: **Larry Paxton, Janet Kozyra, Larisa Goncharenko, Geoff Crowley, Alan Burns, Wenbin Wang**

In order to accommodate the schedule demands of this meeting, this workshop attempted to combine two views of one of the fundamental problems in modeling: understanding departures from the mean state of the ionosphere, thermosphere, and mesosphere (ITM). We can approach the problem by looking at the response to the most extreme perturbations — superstorms — and addressing the question of whether we see "saturation" in either the drivers or in the response. We must also have a thorough knowledge of the mean state and the internal and external drivers that affect the ITM.

Superstorms focus on processes that become evident when the forcing on the system is extreme (i.e., saturation of the polar cap potential, midlatitude great red auroras, oxygen auroras, changes in current systems, changes in conductivity patterns, extreme ionospheric disturbances, etc.) but these same processes are obscured by other processes under milder conditions. The long-term goal of the organizers is to investigate how elements of the global system interact, how nonlinearities develop, how feedbacks impact the global response, etc. From the equations that govern the atmosphere (continuity, momentum and energy) it is readily apparent that thermospheric winds play the unifying role in coupling the thermosphere and the ionosphere. To understand the dynamics we must understand the coupling between the thermosphere and ionosphere during quiet to disturbed conditions, and the problems with modeling and predicting this environment.

The session was very well attended, especially for a session on the last day of CEDAR, with an audience of about 100 people. There were several short presentations during the first part of the workshop, which focused on the superstorm response. In the second part of the session, the emphasis was on delineating the issues of the neutral winds and dynamics.

I. Superstorms

Agenda of talks

- **Larry Paxton** — Introduction and Overview
- **Janet Kozyra** — Outstanding Science Questions for Storms and Superstorms
- **Larisa Goncharenko** — Overview from MLT Storm Workshop
- **Mihail Codrescu/Jon Makela** — Overview from Low and Midlatitude Storm Aeronomy Workshop

Contributed Comments

- **Paul Straus** — Verification of TIMEGCM Low Nightside Electron Density Predictions using GPS Occultations
- **Geoff Crowley** — Modeling the Oct-Nov 2003 Storms
- **Thomas Immel** — IMAGE Observations During Super Storms
- **Hyosub Kil** — Sub-Gridscale Ionospheric Response to Superstorms
- **Yongliang Zhang** — GUVI Observations of Superstorms

- **Tony Manucci** — TEC Issues During Superstorms
- **Ted Llewellyn** — PMC Observations by Osiris During the Oct and Nov 2003 Superstorms

II. Neutral Winds and Dynamics

Agenda of talks

- **Geoff Crowley**—Neutral Winds and Dynamics Introduction
- **Alan Burns**—Outstanding Science Questions related to dynamics
- **John Emmert**—Development of Climatological Wind Models for Storms

Contributed Comments

At the end of the workshop, we took an informal poll of the audience: when asked for a show of interest in a multi-day elaboration of this workshop, the response was overwhelmingly positive. The conveners are working toward planning a multi-day workshop on storms and circulation in the ITM. Interested parties are asked to contact one of the conveners.

LDS5: Comparative Studies of the Polar MLT from Ground and Space

Conveners: **Bob Vincent, Susan Avery, Scott Palo**

Over the past 5 years there has been a significant increase in instrumentation located at polar latitudes with the capability to study the basic structure and evolution of the polar mesosphere and lower-thermosphere. These include radars, lidars and passive optical instrumentation with the capabilities to monitor the neutral winds, measure gravity wave parameters, provide vertically resolved temperature profiles, probe metallic layers and spatially resolve layered phenomena. This increased network of regularly operating ground-based instrumentation is currently augmented by measurements from the SABER, GUVI and TIDI instruments on the TIMED spacecraft that provide regular observations of both the Arctic and Antarctic mesosphere, lower-thermosphere and ionosphere. It was the focus of this workshop to discuss open topics in polar mesosphere and lower-thermosphere (MLT) science that can be addressed given the increasing availability of polar observations.

This workshop was divided into the following areas for focused discussion:

- Current and future instrumentation
- Open scientific questions
- Current initiatives relevant to polar MLT science
- Future workshops and memorandum of understanding

The initial discussion on current and future instrumentation was led by **Bob Vincent** *(U. Adelaide)*. Maps of both the Antarctic and Arctic were shown displaying the location of current instrumentation. From the Antarctic data are available from sites at South Pole (US), McMurdo (US), Davis (Australia), Scott Base (New Zealand), Syowa (Japan), Halley (UK), Rothera (UK), and Zhong Shan (China). These sites create two longitude chains; one at ~68S (Rothera, Davis, Zhong Shan, and Syowa) and one at ~78S (McMurdo, Scott Base, and Halley) in addition to a site at 90S (South Pole). It was noted that there is a large gap in measurements between Adelaide (35S) and the coast of Antarctica (68S) in the southern hemisphere. Discussions about developing a longitude chain near 55S, conjugate to the current northern hemisphere chain, included the possibility of installing future systems in Ushuaia Argentina (55S), South Georgia Island (54.5S) and Macquarie Island (54.3S).

The distribution of sites in the northern hemisphere is more established and comprehensive than that of the southern hemisphere and includes latitude chains around 77N (Svalbard, Resolute Bay, Eureka), 70N (Barrow, Dixon Island, Tromso, ALOMAR), 65N (Poker Flat, Sondrestrom, Esrange, Yellowknife), 55N (Obninsk, Collm, London, Saskatoon). What was obvious from the map is the lack of measurements from Russia, that comprises most of the landmass in the Arctic. There was some discussion about a possible Russian supported effort to install radar systems at Heiss Island (80N) and near the north pole for the upcoming IPY. It could be possible to operate other portable instrumentation in conjunction with these systems if they are supported.

› In addition to the MLT polar sites, **Bill Bristow** *(U. Alaska)* spoke about the growing network of SuperDARN radar systems distributed throughout the Arctic and Antarctic. Bill discussed the current construction and deployment plans for SuperDARN systems in New Zealand, Tasmania, Zhong Shan, Syowa and the South Pole. Thus providing almost full coverage of the southern hemisphere. Of particular interest is the use of SuperDARN radar systems to detect meteors and, hence, provide additional measurements of the neutral winds. Work is progressing to provide regular MLT wind estimates from the SuperDARN network. Such a data set would complement the current ground-based network of wind measurements and would be of great interest to dynamicists.

› **Xinzhao Chu** *(U. Illinois)* spoke about the possibility of locating a portable lidar system on the NCAR HIAPER and the ability of such a system to fly from Colorado to the North Pole and back without needing to refuel. Such a system would enable future gravity wave and noctilucent cloud studies in collaboration with currently operating ground-based instrumentation.

› This part of the workshop concluded with a presentation from **Scott Palo** *(U. Colorado)* about space-based observations of the polar MLT region. This included a discussion on the current availability of TIMED observations and the measurements expected from the near future Aeronomy of Ice in the Mesosphere (AIM) mission. Both the TIMED and AIM missions provide measurements of the polar MLT from space that have not previously been available.

› The second section of the workshop focused on current scientific questions relevant to the polar MLT. This discussion was led by **Susan Avery** *(U. Colorado)* and she began with a report from two previous MLT polar science workshops that were held in Australia (Feb '02, Sep '03). These workshops were largely focused on dynamics. The conclusions from these workshops were:

- The basic state (thermal and dynamical) of the Arctic and Antarctic MLT on a seasonal basis must be determined. This should include a characterization of the zonal average state and any significant, persistent perturbations such as tides, planetary waves and gravity waves or phenomena such as polar mesospheric summer echoes or noctilucent clouds.
- The basic state of the Arctic and Antarctic MLT must be compared to determine if significant asymmetries exists. If such asymmetries exist then an effort to understand their sources should be pursued.
- A specific effort should be focused on analyzing and interpreting southern hemisphere observations from 2002 when a dramatic sudden stratospheric warming occurred.
- Polar MLT observations should not be analyzed in a vacuum. Auroral and upward propagating inputs to the system must be considered.

› Other speakers in this session included **Jeff Thayer** *(SRI),* who discussed the use of incoherent scatter radar (ISR) to probe the MLT and proposed coordinated investigations on:

- Electrodynamic coupling in the polar MLT,
- Onset and evolution of thin ion layers and sporadic sodium layers,
- Effects of polar cap absorption events,
- Structure and evolution of meteor head echoes.

Jeff also spoke about the possibilities for new ISR-related MLT science that will be enabled through AMISR.

› **Irfan Azeem** *(Embry Riddle)* followed with a discussion of the long-term (10 year) Michelson interferometeor OH measurements that have been made at the South Pole. He spoke about trying to lead a collaboration to investigate long-term changes observed in the Antarctic MLT. If you are interested in such a collaboration you should contact Irfan (azeem71d@erau.edu).

› **Kim Cierpik** *(Ph.D. student, U. Colorado)* spoke about her work trying to utilize satellite data in the Antarctic region to extract nonmigrating tidal signatures. Kim is currently using data from the Kyushu GCM as a proxy to prove her method is viable and will then begin working with satellite observations.

› The last speaker during this part of the workshop was **Mike Taylor** *(Utah State)* who provided input on small-scale waves in the Antarctic. Mike proposed three areas for investigation with respect to small-scale waves. These were:

- characterization of wave events,
- identification of wave sources,
- vertical propagation of gravity waves and their influence on the mesosphere, lower-thermosphere and ionosphere.

› **Scott Palo** *(Univ. of Colorado)* led a short discussion in the next session of the workshop on current initiatives that are of interest to the polar MLT community. These included the recent ICESTAR proposal to the Scientific Commission on Antarctic Research (SCAR), the SCOSTEP CAWSES program, the DASI initiative for distributed instrumentation and the international polar year 2007-2008 (IPY). Maura Hagan (NCAR) also mentioned the international heliophysical year (IHY). Details about the SCOSTEP CAWSES program, DASI and IHY were also discussed during the plenary session of the CEDAR meeting. There was some discussion about IPY and the fact that it appears that the middle and upper atmosphere has been largely neglected. However, the Russian group lead by Yuri Portnyagin is using IPY as a mechanism to secure funding to operate a radar at Heiss Island and the North Pole. The ICESTAR program, currently a proposal to SCAR, is requesting support for 5 years to study inter-hemispheric conjugacy effects in the polar regions from the mesosphere through the magnetosphere.

The final section of the workshop included discussion about possible future workshops and the development of a memorandum of understanding. There was broad consensus that future workshops focusing on polar science are warranted and should be planned. The idea behind the memorandum of understanding is to formalize the desire to collaborate and share data products. This is particularly important for polar MLT science that requires considerable international collaboration. Susan Avery is currently in charge of drafting and distributing the memorandum of understanding.

LDS6: First CAWSES Campaign Results

Conveners: **Janet Kozyra, Jan Sojka, Marty Mlynczak**

The purpose of the workshop was to: (1) take a first look at ITM observations during the space weather (25 March – 6 April 2004) and atmospheric coupling (March – April 2004) portions of the First CAWSES campaign, (2) provide a forum for initiating and developing collaborations and, (3) collect science issues on which to focus campaign efforts within the international science community in the coming year. The speakers were asked to focus on interesting features in the data and the new science questions they raise.

Background On The Cawses Campaign: The CAWSES campaign was run in association with the CPEA (Coupling Processes in the Equatorial Atmosphere) campaign (April/May 2004) and the ISR World Day campaign (March 29–April 3, 2004). The focus of the ISR World Days campaign is the coupling between the high- and low-latitude ionospheres. The focus of the CPEA campaign is the coupling from the troposphere up through the thermosphere in a strong convective region over Indonesia. During the ISR World Days, CAWSES functioned to draw together and expand these efforts by coordinating more than 40 collaborating programs (including 20 satellites, all ISR radars, SuperDARN, GPS TEC, and a wide range of ground-based observations listed at http://www.bu.edu/cawses/) to produce a sun-to-Earth data set, which dips down into the lower atmosphere. Another focus is on functioning as a testbed for producing new integrated global maps of important geophysical quantities, including: ULF wave parameters for radiation belt studies, higher-resolution GPS TEC maps, and others to be determined. During the CPEA campaign, CAWSES efforts focus on characterizing equinox conditions in the middle atmosphere, which also serves as global context for the equatorial atmospheric coupling campaign. An effort will be underway to construct global maps of middle atmosphere quantities (i.e., mesospheric winds extended globally with basis functions, etc.) where possible.

Description of Solar Wind Drivers & Resulting Activity: Magnetic activity during this interval includes a high-speed stream with recurrent substorm activity and a 2-day extremely quiet interval followed by two moderate magnetic storms—the first on April 3 due to a slow CME released on March 31, the second triggered by the leading edge of a high-speed stream. The radiation belts were enhanced throughout much of this interval.

The solar wind drivers during the atmospheric coupling campaign changed dramatically between the months of March and April 2004. Powerful high-speed streams from deep within coronal holes dominated in March. These switched to rather weak high-speed streams in April emanating from the edges of coronal holes. Surprisingly enough, the hemispheric power input during these two months indicated that these two types of structures were comparable in geoeffectiveness.

Campaign Results

- Highest levels of odd nitrogen ever seen during entire UARS mission (1994-2004) and corresponding decrease in stratospheric ozone [Jim Russell, Marty Mlynczak]
  - ➜ Question: Is this due to natural variability or is it related to superstorms in late Oct/Nov 2003 coupled with a stable vortex?
  - ➜ Clear correlations between elevated NOx and vortex position suggesting vertical descent is a factor. May be first example from UARS of descent deep into the stratosphere.
  - ➜ Attempts planned to verify and track descent of NOx enhancement using TIMED and UARS – other data sets??
  - ➜ Plans to run the WACCM one atmosphere model with particle inputs from Oct/Nov 2003 superstorms.
- Unusual positive storm effects, storm enhanced density (SED) plume and strong subauroral polarization (SAPs) electric field seen at Millstone Hill. [Chaosong Huang, John Foster]
- First science runs of GAIM, an ionospheric data assimilation model [Jan Sojka]
  - ➜ Equivalent to 3D global map of the ionosphere.
  - ➜ Based on ionosondes and TEC with underlying physics-based model.
- Ionospheric Bubbles and Unusual Wave Structures in the Aurora [Larry Paxton]
  - ➜ Undulating auroras containing structured proton precipitation were observed during both the April 3 and April 5 storms.
  - ➜ Unusual occurrence in the TIMED/GUVI data.
  - ➜ Are these related through the global electrodynamics to the trigger for equatorial bubbles occurring near the same time on these days?
- Convection Features: Extremely quiet SuperDARN convection patterns on April 1 and 2. 115 kV peak polar cap potential drop during storm on April 3. Large swings in IMF By. SAPs fields on April 3 seen around 14 UT. [Mike Ruhoniemi]
- Mid-to-Low Latitude Electrodynamics [Dave Anderson]
  - ➜ Observed prompt penetration electric fields
  - ➜ Attempts will be made to follow development for the first time from the extremely quiet April 2 interval to active conditions.
- New Insights into Coupling to Low Altitudes [Larisa Goncharenko]
  - ➜ New evidence that SAPs electric fields penetrate to low altitudes (down to 150 km) and produce ion and neutral heating.
  - ➜ Clear wave signatures in Ti—propagating from below—seen as high as 160 km.
- Traveling ionospheric disturbances at 1800 UT on day 097 (April 5) seen on 4 consecutive orbits from the CHAMP satellite [Eric Sutton, Jeff Forbes]
- Large enhancement in the 2-day wave and diurnal tide —other interesting activity during same time period [Scott Palo]
  - ➜ MST radar data available from the south pole all the way to Svalbard [http://sisko.Colorado.edu/TIMED].
- FPI Meridional winds over Sondrestrom are reduced in March 2004 over those from 2002-2003 in same season [Rick Niciejewski]

Future Plans

A summary of these results was presented at the CAWSES organizational meeting in Paris on July 17, 2004. Plans are being formulated to begin an international analysis effort, run largely over the internet with workshops at major international and national meetings where possible. The CAWSES website at Boston University will maintain links to sites serving data and distribute information coordinating the international analysis efforts. To be most effective, this analysis effort must rely heavily on national CAWSES programs (already established in Germany, India, China, and Japan; others to follow) as well as national programs like CEDAR covering similar science areas. It is hoped that the CEDAR community can take a lead in the US efforts involving the ITM science by sponsoring a series of CAWSES/CEDAR workshops focused on science issues and by coordinating the US contribution to integrated global maps of important geophysical parameters. With leadership, these integrated global maps will develop into innovative analysis tools (shared by the international community) to address open science questions in ways that have not been possible before. They will also create an important new capability and establish a user community in the years leading up to the I*Y 2007 programs (eGY, IPY, IHY, etc.).

LDS7: Middle and Upper Atmospheric Data Assimilation and Forecast Techniques

Conveners: **Andrew J. Gerrard, Robert W. Schunk**

This workshop allowed both invited and contributing presenters to informally discuss middle and upper atmospheric data assimilation techniques and their use in subsequent forecasting endeavors. The overall goals of the workshop were to 1) raise awareness of the importance and application of such assimilation and forecasting research in the mesospheric and thermospheric regions, and to 2) allow for a unique forum that such topics could be discussed. The 8 AM Friday morning workshop was well attended with over 30 CEDAR researchers, and presentations were given by:

- **R. W. Schunk, L. Scherliess, J. J. Sojka, D. C. Thompson**, Ionospheric Data Assimilation and Forecasting Methods
- **C. Minter,** Neutral Composition Data Assimilation
- **S. Eckermann,** Development of Global Middle Atmosphere Forecasting Capabilities at the Naval Research Laboratory
- **E.M. Dewan and R.H. Picard,** On Forecasting Mesospheric Bores
- **A. Gerrard,** Middle Atmospheric Gravity Wave Forecasting Methods

with shorter contributing presentations towards the end of the workshop by:

- **J. Meriwether,** Global Network of Fabry-Perot Interferometers to Measure Thermospheric Dynamics
- **O. de la Beaujardière,** Communication/Navigation Outage Forecasting System
- **L. Scherliess, R.W. Schunk, J.J. Sojka, and D. C. Thompson,** Ionospheric Data Assimilation Techniques

It became apparent both during the workshop and throughout the week of the CEDAR conference that these particular topics are becoming ever more important in middle and upper atmospheric research. Our understanding of the synoptic nature of the atmospheric system increases dramatically when spatially limited observations are assimilated in real-time with physics-based models. This data assimilation product contributes to ongoing research in tidal, planetary, and gravity wave variability and to our ability to predict ESF and space weather impacts. It also naturally leads to the production of middle and upper atmospheric forecasts, which allows the scientific community to truly test their understanding of the physical processes taking place.

Other than technical conclusions, the overall impressions surmised from the workshop include:

1. A large population of the CEDAR community is ready to progress/expand into a new phase of middle and upper atmospheric research that involves real-time data assimilation and forecasting of the middle and upper atmosphere. This involves a much closer work-

ing relationship between modelers, theoreticians, and experimentalists than currently exists.

2. There is a desire to better organize and publicize such research topics.
3. A number of forecasting efforts are currently underway which require real-time data products (e.g., thermospheric wind and temperature data into the GAIM model of R. Schunk, mesospheric wind data into the global gravity wave forecasts of A. Gerrard, etc.).
4. There is interest in a 2-3 day workshop devoted entirely to these topics, where more time can be given to the discussion and debate of current techniques and infrastructure.

Those interested in material from the workshop and/or interested in attending a 2-3 day workshop devoted to data assimilation and forecasting are encouraged to email Andy Gerrard (agerrar@clemson.edu).

LDS8: Towards an Integrated Data Environment Workshop

Conveners: **Michele Weiss, John Holt, Stuart Nylund**

A workshop on Integrated Data Environments was held on Friday morning. The workshop successfully brought together scientists, data providers, and data center representatives. The workshop provided an opportunity to discuss issues and challenges for future data environments. We shared ideas about future directions, approaches to providing access to data while maintaining an archive, technologies for preserving information content, as well as how one establishes the procedures and practices that ensure that data remains accessible at all points in a project's life.

Twenty five people attended this session, held on the last day of CEDAR. The organizers appreciated the fact that some of the presenters took time out to make contributions to this workshop when they had other presentations in the parallel Storms workshop. This does, in fact, illustrate the fundamental dichotomy of the community: we want to do science but the process takes many forms and requires many contributions.

After a brief introduction, we heard from seven speakers who presented their views and opinions on the needs of the space science communities and included:

- User Concerns and Requirements
- Prioritization of User Needs
- Needs of the Community
- Metadata Standards
- Integrated Data Environment Interoperability

Program

- **Larisa Goncharenko** — What Do We Expect & Desire from Distributed Data Systems
- **Robert Schunk, L. Scherliess, Jan Sojka and D.C. Thompson** — Ionospheric Data Assimilation and Forecasting Methods
- **Aaron Ridley** — Data Sources Which I Use
- **Janet Kozyra** — CAWSES: Testbed for Integrated Worldwide Data Sets
- **William Rideout and John Holt** — Data and Metadata Standards: Lessons Learned from the Madrigal/CEDAR Database
- **Elsayed Talaat, Dieter Bilitza, Jeng-Hwa Yee, Bob McGuire and Stuart Nylund** — Virtual ITM Observatory and the Future ITM Data Environment
- **Barbara Emery, Peter Fox, Jose Garcia, Patrick West, Don Middleton and Stan Solomon** — Towards a Virtual Solar-Terrestrial Observatory

These talks demonstrated that the problem will require continued communication, effort and funding in order to establish an integrated data environment that allows a user to seamlessly locate, acquire, and incorporate data into their research activities. As an outcome of the high interest level in the workshop, an e-mail forum has been established and future venues will be explored. To participate, contact any of the workshop conveners.

OL1: Design Tips for Optical Instrumentation in Aeronomy

Conveners: **Jeff Baumgardner**, **Josh Semeter**

This workshop was well attended with approximately 40 participants in the meeting room at peak attendance.

› **Yan Betremieux** *(SSI)* was the first tutorial speaker. He gave an excellent review of the theory and practical design parameters of Fabry-Perot spectrometers. Parameters affecting the finesse (Free Spectral Range/Instrumental Profile) were itemized, with strategies for maximizing the resolution and throughput. Various methods of scanning, or tuning, a Fabry-Perot spectrometer were presented. It was pointed out that the design calculations required are simpler if they are done in wavenumber space rather than wavelength space.

› Yan's discussion on multiple etalon systems was an excellent lead-in for the next tutorial on interference filters presented by **Jeff Baumgardner** *(Boston University)*.

Interference filters are used in Fabry-Perot spectrometers, monochromatic imagers, grating spectrometers, and photometers. In order to better understand the characteristics and limitation of these filters, a review of the manufacturing steps involved in producing these filters was presented. Graphs illustrating the band-pass shape for a typical filter used in different optical systems were shown. One important property of these filters, the shift toward shorter wavelengths as the angle of incidence increases, was discussed at length. Output from a computer model used to predict the shape of the band pass at various input angles in collimated as well as converging beams was shown. For the range of angles usually encountered in imaging systems, the area under the band-pass curve remains the same but the transmission of the filter to a given wavelength can change dramatically, causing calibration errors. A plea was made for frequent measuring of the band-pass of filters used in the field, and not relying on the curves sent with the filters from the manufacturer.

› **Josh Semeter** *(SRI)* gave a tutorial on the current state of the art of detector systems. Depending on the phenomena to be studied (e.g. fast moving auroral forms, or faint airglow spectra), different kinds of detectors are needed. Intensified CCDs can have fast readout times (>30 fps) suitable for narrow field aurora but suffer from limited resolution and dynamic range. A new type of fast readout CCD was described…the EMCCD (electron multiplying CCD).This device has gain stages on the ccd chip producing intensifier like images without the lag associated with the phosphor and with potentially higher resolution. Currently these devices are only available with 512 x 512 chip sizes. The EMCCD uses a frame transfer technique that may cause smearing of bright, fast moving images. Discussion centered around how the community could get some of these expensive ($40k) cameras to evaluate them for use in aeronomy. A presentation concerning the Signal-to-Noise ratio in images was made using detector parameters such as read out noise, dark signal and quantum efficiency.

› The fourth tutorial discussed general optical design parameters of imaging systems. **Jeff Baumgardner** *(Boston University)* used two designs for monochromatic imagers to illustrate design constraints and characteristics of these systems when used with interference filters. Some ray tracings were shown illustrating the use of field lenses to properly illuminate each pupil in such systems. The use of field flattener lenses was also discussed. The discussion of the pros and cons of the two designs generated some lively audience participation.

› The last tutorial was a short description of the OH temperature Mapper used by **Mike Taylor** *(Utah)*. This instrument makes use of all of the technology discussed in the previous tutorials, consequently there were lots of questions from the audience concerning the design details and data reduction techniques. It was noted that the calibration of such a device is difficult to achieve over the whole sky.

The workshop ended before the topic of predicting the end-to-end sensitivity of an instrument could be addressed. Many participants in the optical workshop indicated that they would also be attending the calibration workshop in the afternoon, and that some of the calibration issues surrounding all-sky cameras would be addressed at that time.

The workshop had lots of audience participation and definitely not an "AGU" style, however, there could have

been even more input from the room. Speakers should ask questions of the room to try and start dialogs, rather than wait to be interrupted. Some attendees asked if there will be a follow-up workshop next year, especially concerning the photometric reduction of all-sky images.

OL2: Optical Calibration Techniques and Issues

Conveners: **Susan Nossal, Mike Taylor, Tom Slanger, Edwin Mierkiewicz**

Accurate calibration is important for comparing observations taken by different instruments, for model-data comparisons, and for acquiring long-term data records. A recurring theme throughout the workshop was that calibration poses a major instrumental challenge for observers. Consistent calibration techniques are critically important when multiple observers contribute to a long-term data set, and when there are upgrades to the instrument(s) acquiring the data set. Participants addressed absolute and relative intensity calibration, as well as spectral calibration. The workshop included a series of short tutorial presentations describing a variety of calibration techniques used by observers in the CEDAR community and a discussion of how to move forward to assist our community in optimizing calibration of optical instruments. Many of the ~50 participants were students who are working with a variety of optical instruments.

Observers at both the Arecibo Observatory and at Boston University use a low brightness Carbon-14 (^{14}C) source to calibrate ground-based optical photometers and spectrometers. However, such a radioactive source is not easily transportable. At the Arecibo Observatory, the ^{14}C calibrated photometer is then used to cross-calibrate the Fabry-Perot by having both instruments simultaneously view the same patch of sky [**R. Kerr**]. A tungsten filament bulb is used by Boston University for cross-calibration of field instruments. This intermediate source is calibrated against the ^{14}C source at the home institution and then used for calibration of the Boston University spectrograph at remote sites [**J. Baumgardner**]. The spectral dispersion of the spectrograph is calibrated through use of laboratory lamps [**J. Baumgardner**].

Mike Taylor of Utah State holds an unexpected participant in the poster sessions. (The birds who live in the Pavilion probably see us as the unexpected guests in their place!)

Larisa Goncharenko of MIT explains her data experiences at the Integrated Data Environment Workshop.

Accurate knowledge of the filter bandpass and transmission profile is crucial for reducing uncertainties in ^{14}C and laboratory lamp brightness calibrations [**R. Kerr and J. Baumgarder**]. This information is especially important when using a continuum source to calibrate a monochromatic emission from the sky. In addition, it is important to characterize the bandpass filter shift to the blue with off-normal incidence angle.

The astronomical community commonly uses standard stars for brightness calibrations [**B. Sharpee**]. The calibration of these stars is tied to blackbody sources. Standard stars are used to calibrate the Keck II Echelle Spectrograph and Imager (ESI) from which aeronomers at SRI obtain the terrestrial spectra contained in the instrument's astronomical observations. When performing standard star calibrations it is crucial that the standard star fall completely within the field of view of the slit utilized by the observer so that the star's entire intensity is captured [**B. Sharpee**].

A nebular calibration method is used for intensity calibration of the University of Wisconsin's geocoronal, galactic, and cometary observations [**E. Mierkiewicz**]. Wisconsin observers point to a patch of the North American Nebula that has been calibrated at the H-α wavelength using Standard Stars. Calibrations at other wavelengths close to H-α can be estimated using knowledge of how the filter transmission and CCD quantum efficiency vary with wavelength. Transferring the calibration to H-β utilizes the filter transmission, CCD quantum efficiency, and atomic physics H-β/H-α line ratios. Nebular calibration offers the advantages of a stable calibration source, a line emission source, and being outside of the Earth's atmosphere, minimizing uncertainty due to atmospheric extinction. Disadvantages include, however, that nebular calibration requires that the instrument have accurate pointing capabilities and that the nebula emit in a wavelength region close to that of the observation of interest [**E. Mierkiewicz**].

The Wisconsin group uses narrow laboratory lamp emissions for their characterization of the instrumental profile and calibration of spectral dispersion [**E. Mierkiewicz**]. A primary challenge of this method is to diffuse the lamp light so that it fills the instrument in a similar manner to the observed atmospheric emissions.

The TIDI instrument on board the TIMED satellite makes global wind measurements of the middle atmosphere. Approximately 5% of the TIDI measurement time is spent on calibration related measurements to insure instrument stability and to characterize any shifts in the instrument during the operation of the TIMED mission [**R. Niciejewski**]. TIDI makes these assessments by observing multiple laboratory lamps and through photon transfer tests to assess the stability of the CCD camera.

Several strategies were discussed to help aeronomers optimize their optical calibration methods. One is to use a clone of the Keck Spectrograph as a brightness calibration source [T. Slanger]. Atmospheric emission bands of known intensity ratios would be used to cross-calibrate a second optical instrument over a wide spectral range.

Another approach is to create a portable calibration instrument. European scientists use the Lindau Calibration Photometer for inter-calibration of instruments and cross-calibration of calibration methods [**M. Taylor**]. The calibration photometer uses a Fritz Peak standard source and makes calibration measurements at seven wavelengths. This photometer is easily portable and is used at annual European Optical Meetings for cross-calibration of instruments. The CEDAR community could consider development of a similar instrument.

Another suggestion made at the workshop was to install monochrometers at the Upper Atmospheric Facilities to enable measurement of filter transmissions. Accurate measurement of the filter transmission properties is required for several calibration techniques. Observers could bring their filters to these facilities to better characterize their filter properties.

Calibration was acknowledged as a continuing challenge for optical observers. Participants suggested that a discussion of calibration strategies and suggestions be incorporated into the Passive Optics Assessment and associated proposals. Most of the tutorial presentations from the Optical Calibration workshop can be found at (http://cedarweb.hao.ucar.edu/workshop/workshops/finalol2.html). We also plan to organize a follow-up workshop for next year's CEDAR meeting. Please contact us with suggestions regarding the format for this workshop and if you'd like to give a presentation.

OL3: New Advances in Observations, Theory and Modeling of Atmospheric Gravity Waves and Bores

Convenors: **Mike Hickey, Steve Smith, Mike Taylor**

This two-hour workshop scheduled for Monday afternoon (June 28th, 4-6 pm), had a short presentation/discussion format and was attended by approximately eighty people. It was convened by **Mike Hickey** *(Embry-Riddle Aeronautical University)*, **Steve Smith** *(Boston University)* and **Mike Taylor** *(Utah State University)*. The session was essentially divided into two sub-sessions.

The first sub-session was chaired by Mike Hickey and discussed the potential role of imaging riometers as a useful tool to measure gravity waves in the upper mesosphere through D-region absorption of cosmic radio noise. It was stressed that this approach would be useful because it would allow imaging measurements of the waves to be made during daylight hours and with overcast skies, which the airglow imagers cannot do. A recent paper on that subject was discussed, and some initial results obtained from a numerical model were presented. Questions and discussions ensued, and overall the ideas appeared to be positively received by those present. The next step is to increase the complexity of the modeling to better understand the interaction between gravity waves and the radio absorption in the D-region, and to quantify what the limitations of this approach might be.

The second sub-session was devoted to mesospheric bores and was chaired by Steve Smith. Mesospheric bores have only recently been identified and so there are many questions as to their identification, their origin, and their modes of propagation. The presentation topics varied from interpretations of all-sky imager observations, the latest modeling results, and also an alternative interpretation using ducted wave modes.

Another important issue that was discussed was that these relatively uncommon events have a similar appearance to other different wave types, such as ducted and large freely-propagating gravity waves, when recorded by all-sky imaging systems. Careful analysis of the vertical phase structure of the disturbance from multi-spectral imaging measurements, as well as simultaneous measurements of the local wind and temperature fields, is therefore necessary to successfully identify and characterize these events.

The workshop was a resounding success with the talks generating several lively discussions. Although it ran over time, finishing around 6:40 pm, some audience members would have stayed longer had they been given the opportunity!

OL4: Transient Optical Emissions in the Atmosphere

Conveners: **Mike Taylor, Mark Stanley**

The session was well attended with about 50 attendees. The session began with a tribute to Les Hale, who passed away on December 26, 2003. Les was the principal investigator on over 100 sounding rocket flights and made numerous contributions to our understanding of the conductivity and composition of the middle atmosphere. Les was highly influential to many other research topics such as the global electric circuit, waveguide propagation, and electromagnetic interference, to name a few.

The main thrust of presentations and discussions for the workshop were divided into two main areas:

1) theoretical and recent campaign results,

2) future research campaigns.

The energetic lightning discharges which produce sprites can cause the entire earth-ionosphere cavity to oscillate at the Schumann Resonance frequencies. Heng Yang (Penn State) showed with his model how these frequencies are modified by X-ray bursts and Solar Proton Events (SPEs). Laurie Triplett (Los Alamos National Laboratory) used a model to predict when the sprite-producing discharges would produce runaway beams and/or narrow streamers, as well as the intensities of the optical emission lines. There was active discussion afterwards about whether sprites ever exist without fine structure in the form of streamers.

› **Ningyu Liu** *(Penn State)* showed results from his streamer model which he has used to predict streamer parameters such as the minimum propagation field, velocity, dimensions, and decay, to name a few.

› **William Beasley** *(Oklahoma University)* discussed the very recent research campaign that was conducted from May 13 to June 21 in association with the TELEX experiment based out of Oklahoma. Aaron Musfeldt looked for sprites with low-light level cameras at night while instrumented balloons were flown with X-ray detectors both within and above storms. They are just beginning to process the data and are seeking collaborations with others who may have relevant data during the time period of interest.

The future research campaigns that were discussed could also benefit from collaborations and the infusion of additional data sources.

› **Stephen Mende** *(University of California, Berkeley)* discussed two projects, SOCRATES and ISUAL, the latter of which had just started collecting data from space on sprites, elves, and lightning. The SOCRATES experiment will hopefully take place in July of 2005 with balloon-based electric field probes acquiring data above sprite-producing storms over the Great Plains while video of sprites are acquired at various sites. Mark Stanley (Los Alamos National Laboratory) gave an overview of the sprite campaign to be conducted at Langmuir Laboratory in mid-July and August 4-21 by researchers from Stanford and elsewhere.

› **Hans Stenbaek-Nielsen** *(University of Alaska, Fairbanks)* discussed his high-speed spectral imaging experiment, which will be deployed in August at Langmuir and will attempt to resolve whether sprite processes are important for the physics and chemistry of the mesosphere. Mike Taylor (Utah State University) discussed the second Brazil campaign, which is slated to take place in February and November of 2005 and will utilize balloons outfitted with X-ray detectors.

At the end of the session, there was active discussion about key issues in our field. The initiation of sprites as well as the transition of some sprites from a column to a carrot appearance were identified as two main scientific problems that need to be tackled. The need for more spectral information on the development of sprites was stated as being essential to discriminating between some competing theories. It was also stressed by one member that in order to get more funding, we need to emphasize issues that are more than just scientifically interesting and have some practical or far-reaching importance as well.

OL5: Science Challenges for the CEDAR (Lidar) Observing Community

Conveners: **Richard Collins, Hanli Liu**

This panel workshop was attended by over 50 CEDAR researchers. The workshop objective was to identify and prioritize scientific questions concerning the middle atmosphere that can be addressed by lidar. The workshop featured presentations by five panelists:

› **Stephen Eckermann:** Gravity waves in the middle atmosphere: Science questions and future directions

› **Ruth Lieberman:** Lidar support for studies of global MLT waves

› **Daniel Marsh:** Chemistry of the middle atmosphere

› **Andrew Gerrard:** Towards the realization of thermospheric lidar systems

› **Alan Liu:** Multi-instrument synergism and clustering

The panelists' presentations were followed by a question-and-answer open discussion.

All of the panelists discussed the role that lidars might play in providing high-resolution measurements of winds, temperatures and constituents that could advance current understanding of the Earth's middle atmosphere. They agreed that these measurements are critical for understanding the distribution of minor species, synoptic-scale weather events, tidal and planetary wave variability, wave-driven fluxes, and non-migrating tides. The panelists noted that in addition to wind and temperature measurements, the measurement of minor species distributions is an important benchmark for modeling both diffusive and turbulent transport. The panelists also noted that current model simulations contain ambiguities

as they can yield similar results with packages that are based on different physical mechanisms.

The panelists urged the CEDAR lidar community to:

- Improve communication between researchers in the CEDAR modeling and observing communities. They encouraged researchers in both communities to better define complementary simulations and observations that answer definitive questions (e.g. flux measurements, wave and tidal characteristics, minor species distributions, wave-breaking parameterizations).

- Address challenges in assimilating satellite and model results and highlight the contribution of ground-based observations to the understanding of non-migrating tides and planetary waves. They encouraged researchers to develop assimilation methods that can combine measurements from ground-based networks with measurements from satellites and global models and encouraged observers to better coordinate regional observing strategies.

- Extend the scope of current lidar measurements beyond the mesopause region to cover the entire middle and upper atmosphere.

- Develop both single-site advanced instrument clusters (of lidars, radars, photometers, and imagers) that can yield specific measurements (e.g. wave-driven fluxes), and multi-site chains of (perhaps less advanced but) cross-calibrated lidars that yield measurements over planetary scales (e.g. temperature structure of non-migrating tides and planetary waves).

PDF copies of the panelist presentations can be obtained from the chairs by contacting them at <rlc@gi.alaska.edu> or <liuh@ucar.edu>.

OL6: LIDAR Workshop Technical Session

Convener: **Jonathan Friedman**

The lidar technical session was called in order to prompt an open discussion amongst the lidar community and other interested members of the CEDAR community as to what technologies should be brought to bear to resolve the issues presented in the CEDAR lidar community self-assessment report. These issues were both specifically science, as well as how to support upcoming facilities such as AMISR and HIAPER. There were about 30 attendees, with about 10 students. With the stage set by the morning workshop roundtable on science issues for future CEDAR lidars, the presently developed techniques for Doppler-resonance lidar were presented.

› **Josef Höffner** *(Leibniéz Institute for Atmospheric Physics, Germany),* presented the technique behind and evolution of the 15-year old mobile IAP lidar. His talk was entitled "A Solid State Scanning Iron/Potassium Lidar for Precise Temperature and Vertical Wind Measurements." He demonstrated how alexandrite lasers can be reliable transmitters for lidar applications. He demonstrated how the IAP alexandrite laser operates reliably over long periods with near-ideal spectral output. Josef showed the system as applied to K and Fe studies of mesospheric temperatures and line-of-sight winds. Finally, he demonstrated that, with optimized present-day technology, there is little statistical difference in temperature and wind measurements made by a solid-state laser-based K and Fe lidar, and those of currently operating Na Doppler lidars.

› **C. Y. (Joe) She** *(Colorado State University)*, presented a talk entitled "Narrowband Sodium Lidar Transmitter: Present Performance and Future Improvements." He began with the history of the CSU Na lidar development and demonstrated its capabilities. Included were examples of the data quality for the full spectrum of observing conditions, including day and night for seasons of maximum and minimum Na density. Joe also showed how this lidar, often described as too complex to be broadly applicable, operates continuously and trouble-free over periods of many days; and he posed the question: Can a system too difficult to operate be robust at the same time? He described the fruits of his own efforts to enhance the laser by introducing solid-state technology, and he concluded by showing the next stage of upgrades to the "Gold Standard" of resonance lidars, by making it fully solid-state, and thus applicable to mobile and remote platforms.

› **Dr. Xinzhao Chu** *(University of Illinois)* presented the technical aspects of the pre-proposal White Paper she co-authored, in a talk entitled: 3-Frequency Fe/Rayleigh

Temperature Lidar for Middle Atmosphere Observations from Research Aircraft and Remote Sites. Xinzhao's talk presented a next-generation Rayleigh-plus-resonance lidar. Improvements to alexandrite lasers in recent years make it an attractive light source not only for the K and Fe lidars, which are already in use, but also a simultaneous Fe resonance and Rayleigh temperature lidar. She pointed out that the simplicity, stability and durability of the system make it attractive to mobile applications, in particular operation on board the new NCAR HIAPER aircraft.

› **Gary Swenson** *(University of Illinois)*, presented "Technologies Evolving for Rayleigh Lidar." Gary showed developing laser technologies that could be applied to Rayleigh lidar. It is clear that solid-state (diode) laser technologies, coupled with fiber amplifiers, portend a great opportunity. Still, the lack of a broad market for the type of laser appropriate for lidar still make these lasers "custom" products.

› **Biff Williams** *(Colorado State University)* presented two promising technologies, one to extend the capabilities of existing Na and K lidars to making upper tropospheric and stratospheric wind measurements, and a second to increase receiver apertures in a way that is economical and transportable. In the first technology, a magneto-optical filter can extend the application of resonance lidar, in particular, for K and Na lidars, to make wind, temperature, and aerosol measurements in the troposphere to mid-stratosphere. These would occur simultaneously with the standard mesospheric W/T measurements. The second technology presented was an economical and transportable multiple-mirrored method for building a 3-m class telescope.

It is clear that there is no obvious "winner" for the next generation of resonance lidar transmitter, as Na, Fe, and K lidars each have their advantages and disadvantages. The tradeoffs and technical issues generated a lively discussion and helped us all to be aware of the fact that, though there is no panacea for middle atmospheric lidar, there is a range of choice of technologies that produce comparable results. Given the issues, the community has decided to hold a retreat in late September to finally hash them out and hopefully emerge united with a proposal for the next Doppler resonance lidar.

S1: TIMED/CEDAR Collaborative Science Workshop

Conveners: **Elsayed Talaat, Larry Paxton, Sam Yee, Jim Russell, Tom Woods, Qian Wu**

The TIMED/CEDAR Workshop was organized into four mini-sessions covering: 1) a quick forum on TIMED instrument data issues and validation; 2-3) an update on two specific themes from the TIMED core mission objectives; 4) an open session on new TIMED results. The session was well attended with an audience of about 70 people. Because of time limitations we requested short presentations to leave time for discussion.

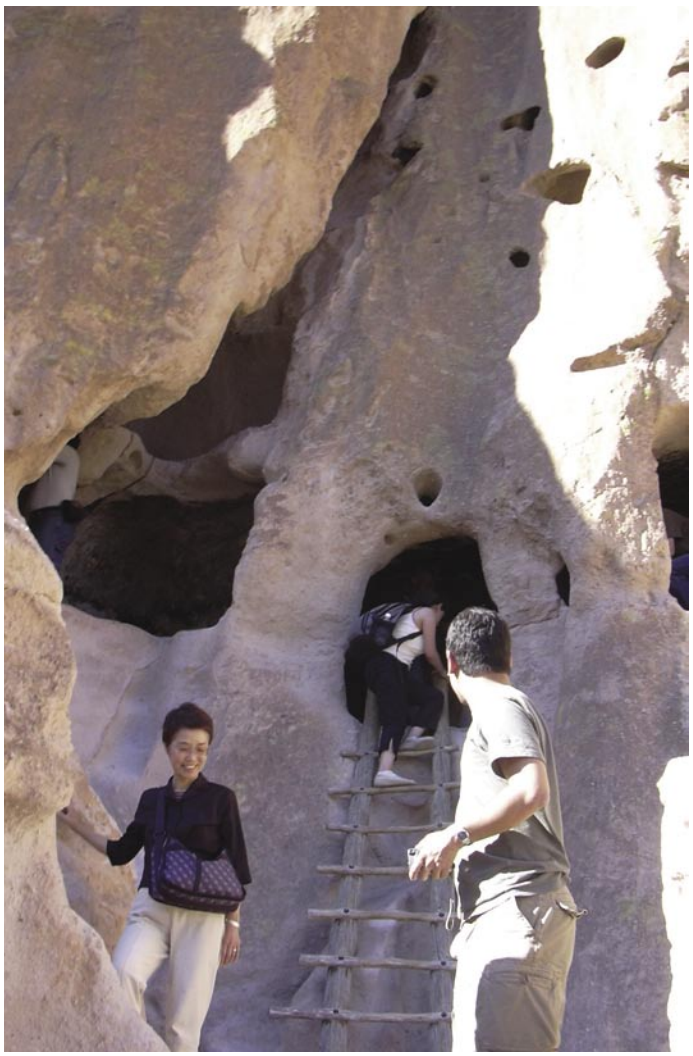
Topic 1: Open Forum on the TIMED Data Team Representatives:

- GUVI – Larry Paxton
- SABER – Jim Russell
- SEE – Tom Woods
- TIDI – Rick Niciejewski

Instrument representatives briefed the audience on a self-assessment of data quality, issues, and availability. In summary, the TIMED data has made good progress in ensuring the quality of the data and in making it available to the public. For more information on the TIMED mission and data products, go to http://www.timed.jhuapl.edu.

› After the instrument question and answer sessions, **Joe She** discussed a collaborative effort to improve the temperature and indirectly validate CO_2 retrievals from SABER ("CSU Lidar-SABER Cooperation", C. Mertens and J. She). Nighttime comparisons of SABER and CSU lidar temperature in the mesosphere and lower thermosphere are improved by 5-6 K by using the SABER-mean retrieved CO_2 profile in the nighttime SABER non-LTE temperature retrieval algorithm versus using a modeled CO_2 profile. The improved SABER/CSU comparisons suggest that the SABER CO_2 profiles represent an improvement in our knowledge of the vertical distribution of CO_2 in the mesosphere and lower thermosphere. In other words, CSU lidar temperatures are being used indirectly "validate" SABER CO_2 vmr and at the same time improve the SABER nighttime temperatures.

› **Jeremy Winick** then presented a study of the inversion layers seen in both SABER and the CSU lidar ("SABER Temperature and OH retrievals and Ground-based Lidar and Imaging of Mesospheric Bores and Similar Events", J. Winick et al.). Temperature profiles from SABER and CSU lidar are consistent and show the same inversion structure in early October 2002. SABER was able to provide the geographical extent of the inversion layer in altitude and the north-south direction. Work is in progress to use extensive SABER data to study the frequency of inversions—relationship to tides and other geophysical parameters



The CEDAR group explores the living space at Bandelier. (They were much smaller rooms than at Fort Marcy Suites!)

Topic 2: Towards Determining the Mean State and its Seasonal Variation

› **Jeff Forbes** provided an overview of his IDS team's ongoing projects to analyze the mean and waves from SABER and TIDI data ("Tides, Planetary Waves and Eddy Forcing of the Zonal Mean Circulation," J. Forbes et al.). These efforts include delineating tides and planetary waves in TIMED data, combining space-borne and groundbased data for wave analysis, and separating the zonal mean from the migrating tides. These analyses will provide direction to model simulations that address the role of tide and planetary dissipation on the zonal mean wind and temperature structure of the MLT region.

› **Qian Wu** presented analysis of the diurnal and semi-diurnal tides in TIDI data and comparisons to modeled tides ("TIDI Observations of Diurnal and Semi-Diurnal Tides", Q. Wu et al.). The TIDI meridional neutral wind data show clear signs of the diurnal and semi-diurnal tides with the diurnal tide at low latitudes being gradually replaced by the semi-diurnal tide at mid-latitudes. The diurnal tide has a vertical wavelength close to 20 km and peaks at about 97 km. The Global Scale Wave Model diurnal tide is comparably smaller in amplitude and longer in vertical wavelength (~25 km) and peaks above 100 km.

The GSWM diurnal tide peaks above 100 km. Both TIDI and GSWM show stronger semi-diurnal tides in the southern hemisphere. In general, the amplitudes of GSWM model and TIDI observation are not inconsistent.

Topic 3: Towards Determining the Radiative Budget of the Middle and Upper Atmosphere

› **James Russell** presented an overview of the radiative balance in the middle atmosphere ("The Radiative Budget of the MLT System: Outstanding Issues", M. Mlynczak et al.). Additionally, he also showed four case studies of issues in radiative balance that are being addressed by SABER measurements. In the first case study, he highlighted how the uncertainties in the CO_2–O quenching rate (a factor of 4 difference between lab and inferred values) can induce significant uncertainties in

radiative cooling and retrieved temperature from SABER. This situation may be remedied by new results combined with TIMED data. The second case study is that the larger NO–O rate coefficient impacts modeling of thermospheric heat budget and interpretation of remote sensing measurements of the NO cooling rate. A combination of NO and CO_2 emission measurements from TIMED may resolve the situation of the effects of the CO_2 quenching rate on the atmospheric cooling and temperature retrievals. Thirdly, the range of values reported for the $O_2(1)$ + O reaction yields a large uncertainty in retrieved H_2O. There is a need to determine the temperature dependence of the newly reported rate and to test using H_2O retrievals against correlative measurements. In the fourth case study, the OH(v) + O rates that are critical to interpretation of SABER data need measurement verification, and determination of the reactive vs. quenching channels.

› **Dan Marsh** presented comparisons between SABER data and simulations from the Hamburg Model of the Neutral and Ionized Atmosphere ("Preliminary SABER/HAMMONIA Comparisons", D. Marsh and H. Schmidt). Good agreement was seen in ozone and temperature between 100 and 10^{-4} hPa. An observed enhancement in the ozone secondary maximum mixing ratio was successfully reproduced by the model and is related to changes in photochemistry brought about by the cool summer mesopause.

› **Geoff Crowley** presented a quick introduction to thermospheric energetics, describing the important heating and cooling terms distribution with altitude and latitude.

Topic 4: Open session on new TIMED results

› **Larisa Goncharenko** presented investigations on the variations in the thermosphere and ionosphere using multi-instrument observations during the April 2002 period, with focus on periods with small geomagnetic disturbances ("Variability in the Thermosphere and Ionosphere During Minor Geomagnetic Disturbances in April 2002 and Its Association with IMF By Orientation," L. Goncharenko, et al.). Large (30-50%) and long-lasting reductions in the daytime electron density were observed at midlatitudes by the array of incoherent scatter radars, ionosondes and GPS receivers. The GUVI data revealed a reduction in the daytime O/N_2 ratio in the coincident area. She suggested that these ionospheric and thermospheric disturbances result from high-latitude energy input and efficient transport of regions with reduced O/N_2 to lower latitudes and emphasized the importance of a strong positive B_y component of the interplanetary magnetic field in the transport of regions with reduced O/N_2.

› **Hyosub Kil** presented an overview of studies that can be performed with low-latitude GUVI data ("New Science Using GUVI Data", H. Kil). For instance, Using GUVI 135.6 nm high-resolution global maps, one can construct a climatology of plasma bubble characteristics and global distribution (latitudinal extent, thickness, and tilt). One can also put together an F-region plasma climatology. With GUVI measurements of the location and strength of the ionization anomaly one is also able investigate the effects of electric field and neutral winds on the global ionospheric morphology during quiet and disturbed periods. Finally, GUVI limb measurements allow the investigation of the growth conditions for equatorial plasma bubbles.

› **Yongliang Zhang** presented highlights of coordinated studies of GUVI and other satellite data ("GUVI New Results", Y. Zhang). Double dayside detached auroras were seen in GUVI and Geotail. Nightside detached auroras were present in GUVI and DMSP, as were undulation in diffuse proton auroras and observations of thin cusp. He also presented comparisons between retrieved O/N_2 from GUVI and IMAGE/FUV, and derived Qeuv from GUVI and SOHO_SEM.

› **Pallamraju Duggirala** presented ground-based observations from Boston using the HIRISE spectrograph that revealed a large enhancement in OI 630.0nm emissions during 1400–1900 LT on October 30, 2003, ("HIRISE Observations of Daytime Aurora Over Boston in Response to the Magnetic Disturbance of October 30, 2003", D. Pallamraju). These enhancements were a factor of 2 to 6 larger than the dayglow emissions of around 4–6 KR observed before 1400 LT on the same day. Sometimes these intense enhancements in the brightness were also visible in the unprocessed (raw) spectral images. The solar zenith angles during these times were as small as 70 degrees, making this one of the first daytime auroral observations from Boston.

S2: CNOFS Forecast — Collaborative Measurements and Campaigns

Conveners: **Odile de La Beaujardière, David Hysell, Michael Kelley, Vincent Eccles, Robert Pfaff, Koki Chau**

C/NOFS (Communication and Navigation Outage Forecast System) is a satellite mission dedicated to forecasting ionospheric densities, irregularities and scintillation. It will be launched early in 2005 in a 13 degrees inclination, 725×375 km orbit. It will have instruments that will provide plasma parameters, electric and magnetic 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.

The purpose of this workshop was to:

- Plan specific campaigns related to C/NOFS.
- Define collaborative projects that involve ground and space measurements.
- Discuss the strength and limitations of the various approaches to nowcast and forecast ionospheric and scintillation parameters at low latitudes.

Information on C/NOFS is available in http://www.vs.afrl.af.mil/factsheets/cnofs.html.

The announcement of opportunity for a joint NASA/NSF science program related to C/NOFS and equatorial ionosphere is schedule to go out as soon as the NASA reorganization is accomplished.

Major issues that were discussed, concerning the ambient ionosphere / thermosphere, and equatorial plasma irregularities included the following:

- Role of wind shears, tides, gravity waves and E-region conductivity in the onset and damping of equatorial irregularities.
- Modeling of the perturbation electric field at low latitudes, and its dependence on solar wind, magnetospheric parameters, as well as ambient ionosphere.
- New and innovative techniques for ionospheric and thermospheric remote measurements.

The following contributions were made:

(Note: Some contributions had to be extremely short for lack of time; not all contributions are listed; the titles are shortened in the list below)

- **Odile de La Beaujardière** — C/NOFS status
- **Bob Robinson** — Joint NASA/NSF announcement of opportunity
- **Dave Hysell** — Jicamarca results, Kwaj Rockets status
- **Mike Kelley** — Instability triggering
- **Chin Lin** — Longitudinal propagation of EPBs
- **Maura Hagan** — Coupling from below
- **Astrid Maute & Arthur Richmond** — Currents modeled with TIEGCM
- **Koki Chau** — Jicamarca ESF observations around dawn
- **Bill Wright** — Dynasondes—new results from old data
- **John Makela** — Ground-based imaging and ROCSAT-1
- **Larry Paxton** — DMSP SSUSI status
- **Dave Anderson** — Delta H vs ExB Drift Velocity Relationships
- **César Valladares** — Flux tube measurements in South America
- **Paul Straus** — Opportunities related to the CORRIS instrument
- **Bob Vincent** — MLT radar in the Pacific

Lidar and Airglow Self-Assessments

Copies of the 2004 Lidar self-assessment document for NSF and additional community contributions are located on the web at http://cedarweb.hao.ucar.edu (click on 'Community' and then on 'Documents').

The reference list and preliminary 'nuggets' that may contribute to the equivalent Passive Optical self-assessment are on-line at the same location. Further additions will be made to the Passive Optical web page as they are received. The first draft of the document is due at NSF in early November. Please contact John Meriwether (john.meriwether@ces.clemson.edu) with any questions or input.

AMISR Development is Underway

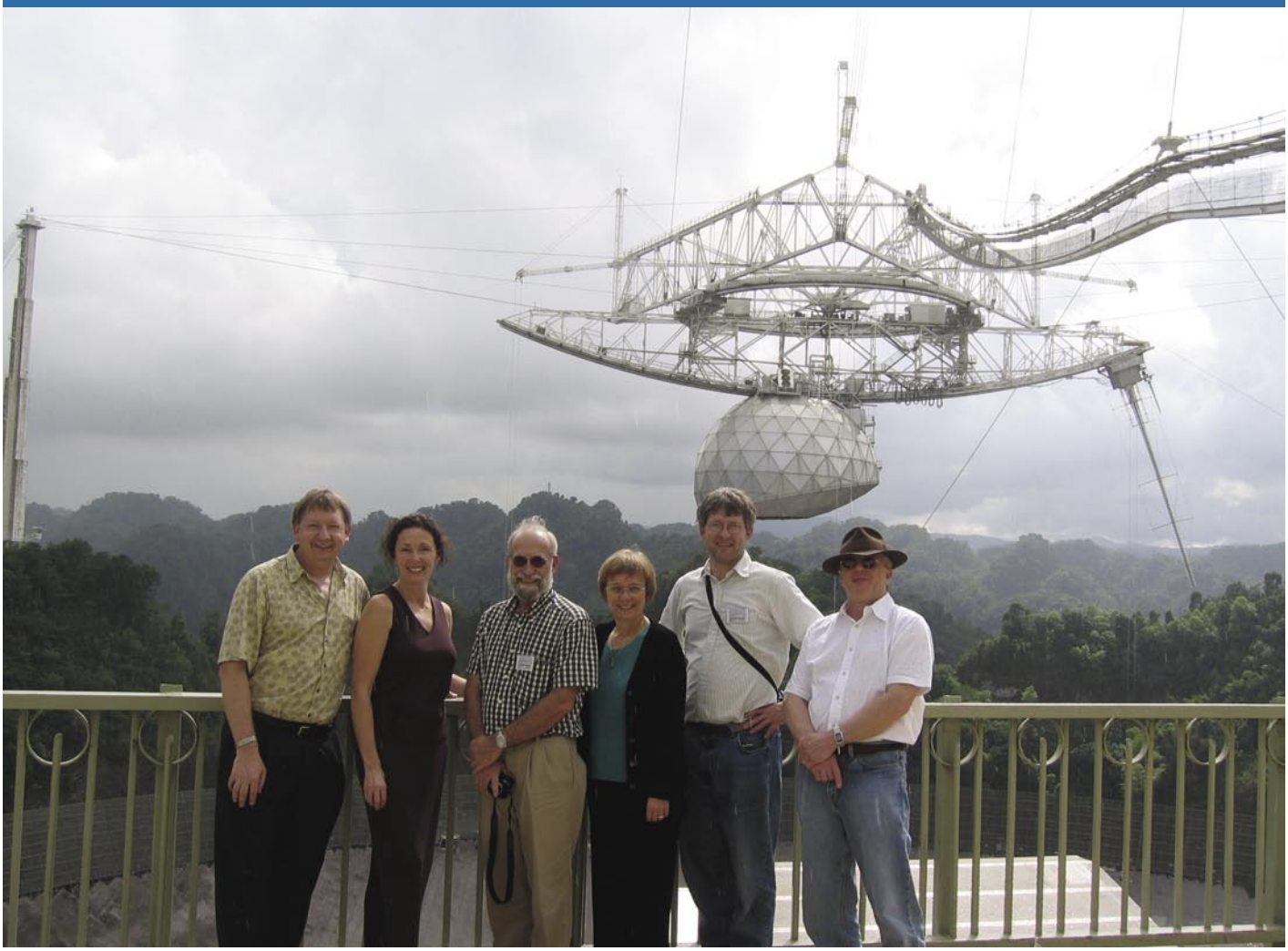
The Advanced Modular Incoherent Scatter Radar (AMISR) is currently under development, led by a team of scientists and engineers at SRI International. The project will achieve a major milestone in September 2004 when a small prototype radar will be shipped to the Jicamarca Radio Observatory in Peru for initial testing and scientific observations. The biggest challenge confronting the team is the design and manufacturing of more than 12,000 solid-state antenna element units that will comprise three individual phased-array radars. The first radar will be deployed in Alaska in the summer of 2005, and the second and third radars will be deployed at Resolute Bay, Canada, in the summers of 2006 and 2007.

The AMISR Project Office at SRI receives technical input on a regular basis from a Technical Advisory Committee chaired by Tony Van Eyken, EISCAT Science Director. Regular attendees of CEDAR Workshops will recognize many familiar faces among the AMISR development team and technical advisors. AMISR represents a tremendous success story for the CEDAR community, and the observational capabilities the new radars provide will inspire a new age of ionospheric research.

The AMISR team at SRI. Top from left: Rudy Cuevas (on loan from Cornell), Todd Valentic, Moyra Malone, Shelly Easterday; bottom row: John Kelly, Mike Cousins (with one of 12000 antenna element units), John Buonocore, Craig Heinselman.

AMISR Technical Advisors: From left: Allan Schell, Livio Poles, Erhan Kudeki, Tony Van Eyken, Mike Sulzer, Dave Barton, Brent Watkins, and Frank Lind.

Upper Atmospheric Facilities Review Finalized



Upper Atmospheric Facilities Program review panel members: from left, Mike Taylor, Maura Hagan, Bob Clauer, Susan Avery (chair), John Sahr, and John Mathews.

The final version of the Upper Atmospheric Facilities Review has been officially submitted to NSF. The report from the panel will soon be placed on the NCAR CEDAR homepage. Susan Avery chaired the six-member panel, which visited all four of the NSF-support incoherent scatter radars and the SuperDARN operations office at the Applied Physics Laboratory in Laurel, Maryland. The report is an excellent review of the scientific and technical accomplishments enabled by these facilities. The report also includes important recommendations for better meeting the goals of the facilities program. As a result of these recommendations, the future will undoubtedly see a stronger partnership between the facilities and the broader atmospheric and space science community. Please take time to read the report upon its release and feel free to submit your comments to NSF or any facility staff member.

Letter from Program Director

The Fiscal year 2005 (FY-05) CEDAR competition reflects a new vigor in the program, and that re-invigoration is also demonstrated in the core Aeronomy program. There are thirty-three proposals in the FY-05 CEDAR competition, including nine in the CEDAR postdoctoral competition. That is one of the highest subscription rates in the 19-year history of CEDAR, and is a dramatic change from FY-04, when just sixteen CEDAR proposals (including four postdoctoral proposals) were received. The total request for first-year grant support in FY-05 CEDAR is about $ 3M, making an average request of $89 k per year. Depending on grant size, the FY-05 CEDAR budget will award roughly one-third of the proposals submitted, a success rate well below what we have experienced in the past. The proposals are being reviewed by both mail-in reviews and a nine-member panel.

The NSF core aeronomy program is also vigorous, with 26 submissions for FY-05 funds already received. The total request to core NSF Aeronomy is nearly identical to CEDAR, totaling $3M at this writing. Because, at the time of this writing, the FY-05 start is still one month away, NSF Aeronomy expects many more requests for FY-05 funds, and a success rate near just 20%, compared with 50% in FY-04. It seems unfortunate that demonstrable new vigor in our community coincides with projections for flat or even slightly reduced budgets for NSF Aeronomy in the coming years. However, that community pressure is also timely, serving as a fence against budget raids from programs with even more dramatic budget stress.

Diversity continues to be a challenge in the CEDAR community. Although the CEDAR workshop attendance showed unprecedented diversity, this is not being reflected in the submission of proposals from under-represented groups.

It is likely that only one or two of the nine post-doc proposals submitted to this competition will be funded. Post-doc applicants are reminded that a second competition for CEDAR postdoctoral awards will occur in FY-05, so that the CEDAR, SHINE, and GEM communities will have synchronous competitions for postdoctoral awards. The submission deadline for the second CEDAR postdoctoral competition in FY-05 is Monday, February 7, 2005, and information about the competition can be found at: http://www.nsf.gov/pubsys/ods/getpub.cfm?ods_key=nsf04573.

Because NSF requires proposals to be awarded or declined within six months, proposers should contact me before submitting proposals after February, 2005. Limited Aeronomy program funds during the Spring and Summer of 2005 will make it difficult to fund proposals received after February, and holding proposals until FY-06 is discouraged by NSF.

— Bob Kerr
Program Director
NSF GEO/ATM Aeronomy

2004-2005 CEDAR Science Steering Committee (CSSC) Members

Let's Help Save the Trees *(along with printing & mailing costs)*!

Each issue of the CEDAR Post is posted on the web, which Barbara Emery announces at the time of completion. If you are willing to give up your paper version of future issues and access the electronic version instead, please e-mail Jill Morrison at jtm14@cornell.edu. Thank you for your kind consideration!

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