The Cedar Post

September 1992 No. 17

CEDAR in Peru: The Jicamarca Radio Observatory

The Jicamarca Radio Observatory (JRO) is the equatorial anchor of the Western Hemisphere chain of incoherent scatter radar (ISR) observatories extending from Lima, Peru to Søndre Strømfjord, Greenland. The Observatory is about a half hour drive inland (east) from Lima, Peru at geographic latitude 11.95° south, longitude 76.87° west. The magnetic dip angle is about 1°, and varies slightly with altitude and year. For critical applications it can be determined extremely accurately with the radar, which can be pointed exactly perpendicular to **B** up to altitudes of 800 km or so. The altitude of the Observatory is about 500 m ASL. It is about 10 km from the Carretera Central, the main highway east in Peru.

History. The Observatory was built in 1960-61 by the Central Radio Propagation Laboratory of the National Bureau of Standards. This lab later became part of ESSA and now NOAA. The first incoherent scatter measurements at Jicamarca were made in late 1961. In 1969 ESSA turned the Observatory over to the Instituto Geofisico del Peru (IGP), which had been cooperating with CRPL since at least the IGY in 1957–58, and probably before, and had been intimately involved with all aspects of the construction and operation of Jicamarca. ESSA and then NOAA continued to provide some support for the operations for several years but then phased out their financial involvement. The National Science Foundation then began partially supporting the operation of Jicamarca, first through NOAA, and since 1979 through Cornell University via a Cooperative Agreement. This Agreement now provides most of Jicamarca's funds; Peru contributed significant support in the past, but its contribution has diminished drastically in recent years with the collapse of the Peruvian economy. A side effect of this collapse has been very low salaries at Jicamarca, dictated by Peruvian Civil Service regulations, even though most of the financial support is from the U.S. This problem has at last been solved and we are now able to pay the employees competitive salaries (by Peruvian standards at least; the salaries are still far below U.S. levels). A private, nonprofit Peruvian corporation called Ciencia Internacional has been formed that hires and pays most of the staff members, thus avoiding government hiring restrictions and salary ceilings.

Radar facilities. The 49.92 MHz ISR is the principal facility of the Observatory. The radar antenna consists of a large square array of 18,432 half-wave dipoles arranged into 64 separate modules of 12 x 12 crossed dipoles. Each linear polarization of each module can be separately phased (by hand, changing cable lengths), and the modules can be fed separately or connected in almost any desired fashion. There is great flexibility, but changes cannot be made rapidly. The individual modules have a beam width of about 7°, and the array can be steered within this region by proper phasing. The one-way half power beam width of the full array is about 1.1°; the two-way (radar) half power width is about 0.8°. The frequency bandwidth is about 1 MHz. The isolation between the linear polarizations is very good, at least 50 dB, which is important for certain measurements. Since the array is on the ground and the Observatory is the only sign of man in a desert region completely surrounded by mountains, there is no RF interference. The transmitter consists of four completely independent modules which can be operated together or separately. The transmitter is being slowly converted to a new design, using modern tubes. Two modules are currently operational with this new design and deliver peak powers of ~1.5 MW each, with a maximum duty cycle of 6%, and pulses as short as 0.8–1.0 μs. Pulses as long as 2 ms show little power drop; considerably longer pulses are probably possible. The last old style tube died recently, and so the other two modules are not usable until we finish their conversion, which is well advanced for the third module and partially done for the fourth. The drivers of the main transmitter can also be used as transmitters for applications requiring only 50–100 KW of peak power.

There are 3 additional 50 MHz "mattress" array antennas steerable in the E-W direction only. Each consists of 4 x 2 half-wave dipoles mounted a quarter wavelength above a ground screen. Two of these arrays can handle high powers. There is also a single fat dipole mounted a quarter wavelength above ground that can handle at least a megawatt. There is a lot of land around the Observatory for additional antennas for special experiments. Arrays of a kilometer or more in length could be set up. There are four phase coherent receivers for the radars. These mix the signal to baseband (with two quadrature outputs each), with maximum output bandwidths of about 1 MHz. Filters are available with nominal time constants ranging from 1 to 500 μs. As many as eight data channels (four complex pairs) can be sampled simultaneously with 125 m (0.83 μs) resolution and fed to a large FIFO buffer/coherent integrator, and from there to the computer. We are in the process of designing new receivers; we plan to have at least eight, with more precise digital filtering at the output.

The computing hardware at JRO is constantly evolving. The main data-taking computer is still a Harris 800, with a 1600/6250 bpi (75 ips max) tape drive and two Exabyte 2.2 GByte 8 mm cassette tape drives (maximum writing speed of 256 KBytes/s). There is also now a Harris Nighthawk computer (UNIX operating system) with an 80 MFLOPS array processor at Jicamarca. We do not yet have the Nighthawk interfaced to the data acquisition hardware yet, but we hope to do so soon. The Harris computers are very good for real time radar applications because they have multiple I/O ports with a separate processor for each.

Other facilities. A Digisonde Portable Sounder from the University of Lowell was installed late last year and is now operating. The DPS is battery operated and therefore will be unaffected by power outages. It has four receivers and hence can measure drifts as well as density profiles. There have been a few minor start-up problems (e.g., with the battery system, since the power outages are sometimes longer than the system was designed to deal with), but most of these have been solved. We plan to compare digisonde and ISR F-region drift velocity measurements soon. We hope to acquire a modern magnetometer for the Observatory in the near future. The University of Tromsø, Norway, has offered to donate one to JRO.

Additional observatories and facilities in Peru. (1) There is a major airglow facility in Arequipa in southern Peru. Proposals for a major upgrade of the observing equipment have been submitted. (2) Most of the NOAA Poker Flat MST radar has been transported to the University of Piura in northern Peru and is now operating. Piura is approximately 800 km north of Jicamarca at about 4° S geographic latitude and is the eastern anchor of the NOAA pacific equatorial chain of MST radars. The University of Piura has been extremely helpful and competent in this project. There is a good opportunity for collaborative MST observations with Jicamarca, comparing equatorial (geographic) and off-equatorial behavior, for example. Conversely, Piura is at the northern edge of the magnetic equatorial region, and so there may be opportunities for interesting E- and F-region plasma instability comparisons. And lastly, the skies at Piura are almost always extremely clear; it could be an excellent airglow observing site. (3) Satellite scintillation measurements are made at Ancon (about 50 km northwest of Jicamarca on the coast) on a campaign basis by the Basus and their colleagues. (4) There is a rocket range 50 km or so south of Lima that has been used twice by NASA (1975 and 1983) and once by Germany (1979).

CEDAR activities. Jicamarca participates in all the ISR World Day runs, of course, thereby supporting assorted CEDAR initiatives such as GISMOS, LTCS, SUNDIAL, etc. The newest CEDAR programs involving Jicamarca are CADRE and MISETA. The CADRE (Coupling And Dynamics of Regions Equatorial) campaign, coordinated by D. Fritts, will examine the dynamical coupling processes operating within and accounting for the large scale structure and variability of the equatorial middle atmosphere. Using a wide range of radar, lidar, optical, rocket, and satellite instrumentation, this program will examine the small and large scale motions of this region, their spatial and temporal variability, their responses to source variability, and their forcing of the middle atmosphere. The role of Jicamarca in CADRE will be to address the effects and transports due to small scale gravity waves, specifically their vertical fluxes of momentum, their interactions with tidal and other equatorial motions at larger scales, and their forcing of the QBO and SAO at stratospheric and mesospheric heights. Initial observations are planned for January 1993 with more extensive coordinated measurements planned for October 1993. The Jicamarca radar is the most sensitive MST radar in the world; in fact, it is the only true MST radar, capable of probing even the "gap" region near 45–50 km, partly because of its long wavelength (so there are less problems with the turbulent viscous cutoff), and partly because it has the largest power-aperture product of any VHF radar.

MISETA (Multi-Instrumented Studies of Equatorial Thermospheric Aeronomy), coordinated by J. Meriwether, will investigate F-region winds and zonal plasma drifts using Fabry-Perot interferometry and all sky imaging at 630 and 774 nm from Arequipa, scintillation drift measurements at Ancon, and digisonde and ISR drift measurements at Jicamarca. The various observations will be compared, and also compared with specialized runs of the TIEGCM model. One goal is to understand why scintillations develop on some nights but not others. The first campaign is tentatively scheduled for April–May of 1994, a period which should include both quiet and disturbed nights.

Of all the ISR observatories, Jicamarca provides by far the most accurate drift velocity and electric field data. This is because of the unique equatorial geometry. Pointing perpendicular to the magnetic field makes it possible to measure line-of-sight drift velocities to accuracies of the order of 1 m/s without difficulty. Vertical F-region plasma drifts of this accuracy translate to zonal electric field accuracies of about 25 μV/m. Determining zonal drifts involves subtracting two slightly off vertical line-of-sight measurements, and so the uncertainties are about ten times larger, but the mean drifts are also larger. By studying the variation of drift velocity with altitude, up to altitudes of 800–1000 km or perhaps even higher, it is possible to study the electrodynamics of the entire low latitude ionosphere, up to the anomaly latitudes, because of the way the electric field maps along the geomagnetic field lines. Jicamarca also has a unique capability to probe the ionosphere to very high altitudes. Because of the long radar wavelength, the incoherent scatter is not affected by Debye length problems at low electron densities, and usable signals can be obtained from altitudes of 5000 km and higher, giving densities and perhaps temperatures (but not drifts since the beam cannot be pointed perpendicular to **B** much above 1000 km).

Other scientific programs. (1) Jicamarca has had a long standing (since the early 1960s) program of radar studies of plasma instabilities in the equatorial E- and F-regions. The E-region instabilities are driven by the equatorial electrojet current and are quite similar to instabilities found in the auroral E-region. The effects are slightly weaker at the equator, but the equatorial geometry and the power and versatility of the Jicamarca radar make the essential physics much easier to study at the equator. The sometimes spectacular F-region instabilities are unique to equatorial latitudes. Both are nice examples of fully developed (nearly), two-dimensional plasma turbulence and provide a unique laboratory for studies of some fundamental nonlinear plasma processes. (2) Even without a magnetometer it has been possible to measure small changes in the Earth's magnetic field during the lifetime of the Observatory because we can determine very accurately via interferometry the exact point at which the radar beam is perpendicular to **B**. (3) MST radar observations with excellent resolution and altitude coverage can be made from Jicamarca, as mentioned above in connection with the CADRE program.

Sendero Luminoso. There has been quite a bit of coverage in the U.S. press about terrorist activity in Peru. The Sendero Luminoso (Shining Path) movement has been causing serious problems in the country, but this activity so far has had no effect whatsoever on visiting scientists or on the operation of the Observatory, except for causing more frequent power interruptions than was the case in the past. Jicamarca keeps a low public profile, and the fact that the only road to JRO passes within a few meters of a military base is also reassuring. There are always six armed police at the Observatory (similar to the situation at Arecibo and other large observatories), but they have never been called upon to do anything. Lima has become a more dangerous place than in the past, with a recent series of random car bomb explosions (again, a phenomenon not unique to Lima, unfortunately), but most visitors to JRO stay at the El Pueblo resort hotel, which is very nice, relatively inexpensive by U.S. standards ($50 or so per day), outside of Lima, and only a short 10 km drive from Jicamarca. In August of this year a visitor to Jicamarca traveled to the justly famed tourist attractions of Cuzco and Macchu Picchu in the Andean interior and reported that he had a fabulous time, and that there were plenty of European tourists but not many Americans. It all depends on what newspaper you read, perhaps. (A late note: The founder and leader of the Senderos, Abimael Guzman, was captured in mid-September, along with seven of his highest ranking associates. Perhaps this will turn the tide against the movement.)

Scheduling and costs. Scheduling experiments at Jicamarca is still handled in an informal way; so far we have managed to avoid setting up a formal procedure. Anyone wishing to observe at Jicamarca should get in touch with D. Farley at Cornell and/or R. Woodman at JRO. Remember to avoid the ISR World Day periods (see the International Geophysical Calendar). Periods around July 28 (Peruvian independence day, a big holiday period), Easter, and Christmas are also times when key personnel may be absent. The staff normally works four 10-hour days per week (Monday–Thursday), partly so that they can hold other jobs. If you plan to run at night or during Friday–Sunday, you should be prepared to pay overtime charges to the staff members involved. These charges might add up to $30–50/hour, depending upon the number of people involved. The staff members are generally very happy to work overtime, because the payments represent a substantial boost to their income.

If your research is sponsored by the National Science Foundation, there is no charge for observing time, other than for possible overtime, as just discussed. For those with other funding, there is a charge of approximately $5000 per day of observing, for isolated experiments. For longer, ongoing programs not supported by the NSF, special arrangements for Observatory support should be made.

Donald T. Farley, Cornell University

New CEDAR Science Steering Committee Members Begin Three-Year Terms

Coordination of the CEDAR Program and the organization of the annual workshop are the responsibilities of the CEDAR Science Steering Committee. The CSSC includes nine scientists who serve staggered three-year terms. The NSF program directors for aeronomy and for upper atmospheric facilities serve as ex officio members. At the conclusion of this year's workshop, Sunanda Basu (the new NSF Aeronomy Program Director), Bela Fejer, and Chet Gardner completed their terms on the committee. All three provided exceptional leadership, which has been greatly appreciated. Their collective insight, wisdom, and experience have been very important in helping to shape the CEDAR Program during the past three years.

The CEDAR Program is fortunate to have well-qualified replacements for Sunanda, Bela, and Chet. Miguel Larsen from Clemson University, Jeff Forbes from Boston University, and Tim Killeen from the University of Michigan are the new CSSC members and began their terms in June at the annual workshop, at which time Michael Kelley also became the CSSC Chairman.

Listed below are the names and addresses of the current CSSC members for 1992-93:

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Dr. James H. Hecht
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Sunanda Basu Becomes New Program Director for Aeronomy at NSF

On September 1, Dr. Sunanda Basu began a leave of absence from Boston College to serve a two-year term as Program Director for Aeronomy at the National Science Foundation. She replaces Fred Roesler of the University of Wisconsin. Sunanda has published extensively in the area of ionospheric irregularities and their effect on communications. We welcome her and wish Fred all the best on his return to academia.

Dr. Basu's NSF address and communication numbers are:

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Robert Robinson to Take Over the Upper Atmospheric Facilities Program

Dr. Robert Robinson will replace Dr. Richard Behnke this Fall as Program Director for the Upper Atmospheric Facilities while on leave from the Lockheed Palo Alto Research Laboratories. Bob is well suited for this task, having utilized both the Chatanika and Sondre Stromfjord Facilities for over a decade.

Dr. Robinson's NSF address and communication numbers are:

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The 7th CEDAR Workshop

The National Science Foundation (NSF) program on Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) held its seventh summer workshop in Boulder, Colorado from June 21 through June 26, 1992. About 283 people from around the world attended the plenary meetings and workshops on topics related to ground-based observations of atmospheric regions from the stratosphere to the magnetosphere. This year, 128 students (mostly graduate level) participated. This is an increase over last year of 11 students.

The CEDAR Workshop was hosted by the High Altitude Observatory (HAO) at the National Center for Atmospheric Research (NCAR), with support from the University of Colorado and the National Institute of Standards and Technology (NIST). On Sunday, many attended a radar school held at NIST. In the mornings, Monday through Friday, plenary sessions were held at NIST, with afternoon workshops at the Mesa or Foothills Lab. Colin Hines of the Arecibo Observatory gave a talk on gravity waves for the CEDAR Prize Lecture, and there were five tutorial lectures at the plenary sessions. The tutorial speakers included middle atmosphere talks on metallic layers by John Plane of the University of East Anglia and polar mesospheric clouds by Eric Jensen of NASA Ames. Upper atmosphere tutorials were given by Ray Roble of HAO/NCAR on numerical simulations, and by Mike Lockwood on time-varying convection. Judith Lean of the Naval Research Lab gave a tutorial on solar variability and global change from the troposphere and up. Copies of the lecture notes or videos for the radar class, tutorials, and CEDAR Prize Lecture can be obtained by contacting Barbara Emery (HAO/NCAR, P.O. Box 3000, Boulder, CO 80307, (303) 497-1596, FAX (303) 497-1589, emery@ncar.ucar.edu or 9580::"emery@ncar.ucar.edu"). The notes are free. The videos contain about 9 hours on 5 tapes. NTSC (regular VHS) copies of the entire set will cost $75, while PAL or SECAM copies will cost $200.

The annual poster session was held in the Mesa Lab. lobby Tuesday and Wednesday mornings. Most of the posters were presented by students, and prizes were awarded for the best student posters for each session and the best runner-up. This year, prizes went to Richard Collins of the University of Illinois for a poster on lidar at the South Pole, and to Susan Nossal of the University of Wisconsin for a poster on the geocoronal Balmer-Alpha line. The best runner-up was Imad Barghouthi of Utah State University who showed a poster on self-collisions and the non-Maxwellian F-region ion distribution function.

The fifteen workshops this year ranged from nightglow variability to problems related to ionospheric modeling and observations. One workshop focused on accessing the CEDAR Data Base, located on NCAR's mass storage system and accessed via a dedicated CEDAR computer in HAO.

The conference was preceded by a workshop on High-Latitude Plasma Structures (HLPS) the weekend before at Peaceful Valley, and was followed by a GEM (Geospace Environment Modelling) workshop the following week at Snowmass.

Odile de la Beaujardiére, SRI International
Barbara Emery, NCAR

1992 HLPS/GAPS Workshop Held at Peaceful Valley, Colorado

The HLPS (High Latitude Plasma Structures) Group of CEDAR with its Solar-Terrestrial Energy Program (STEP) Working Group 3 counterpart GAPS (Global Aspects of Plasma Structures) held a joint three-day Workshop during June 18-20, 1992 at the Peaceful Valley Lodge and Conference Center, Lyons, Colorado, located about 30 miles from Boulder in a pleasant mountain environment. The beautiful location, together with the meeting format which provided free afternoons, maximized interactions between participants, a feature that graduate students, in particular, found to be very productive. Sixty-one participants attended the meeting which was funded primarily by the CEDAR program of NSF with a small supporting grant from SCOSTEP. The STEP participation came through the attendance of 15 scientists representing the following countries: two each from Russia, Norway, and United Kingdom, and one each from Canada, France, Denmark, Germany, Peru, Australia, Japan, Taiwan, and Turkey. A noteworthy feature of the Workshop was the presence of 12 graduate students and 4 post-docs who took an active part in the deliberations.

The first day of the Workshop was devoted to polar cap patch and auroral blob observations and their modeling with Ed Weber and Rod Heelis as Chairs. The second day was likewise devoted to polar cap sun-aligned and auroral oval arc observations and their modeling with Jim Vickrey and Jan Sojka as Chairs. Michael Kelley led the discussion on the last day which was concerned with mid-latitude irregularities. A multi-diagnostic approach was found to be very useful in studying the entry mechanism of patches into the polar cap. For arcs, carefully coordinated optical and radar measurements provided a wealth of information.

The Workshop was very successful in achieving a close coordination between experimentalists and modelers in both the polar cap patch and sun-aligned arc sessions. It is crucial that this synergism be fostered so that a complete understanding of the plasma structuring at high latitudes under both Bz north and south conditions be obtained. The mid-latitude irregularity session had a large number of speakers from around the world discussing both E- and F-region irregularities. These scientists are planning several conjugate experiments during the waning sunspot years when mid-latitude irregularities are more prevalent.

Each participant at registration received a compilation of the papers to be presented at the Workshop. The graduate students found this very helpful in following the presentations. A selection of papers from this Workshop will be published in a special section of Radio Science. **The deadline for submission of manuscripts is December 1, 1992.** Sunanda Basu will serve as Guest Editor. However, because of her new position at NSF, she has decided to relinquish the leadership of the HLPS Group. Jan Sojka of Utah State University and Ed Weber of Phillips Laboratory will jointly serve as Co-Chairs to guide the future activities of this group. Dr. Basu plans to stay on as STEP GAPS Project Leader for the present.

Sunanda Basu, NSF

FY 1992 CEDAR Awards

In FY 1992, NSF received 50 CEDAR proposals requesting over $5.2M. The amount of funding available was about $1.6M.

As in past years, the FY 1992 CEDAR proposals were first reviewed by mail, and then discussed and ranked by a panel of experts. The panel met on Monday, March 16 and Tuesday, March 17, 1992. The panel consisted of 9 senior scientists, all with a deep understanding of the CEDAR program. Rich Behnke and Fred Roesler, Program Directors for Upper Atmosphere Facilities and Aeronomy, respectively, were present to provide program information requested by the panel throughout the discussions.

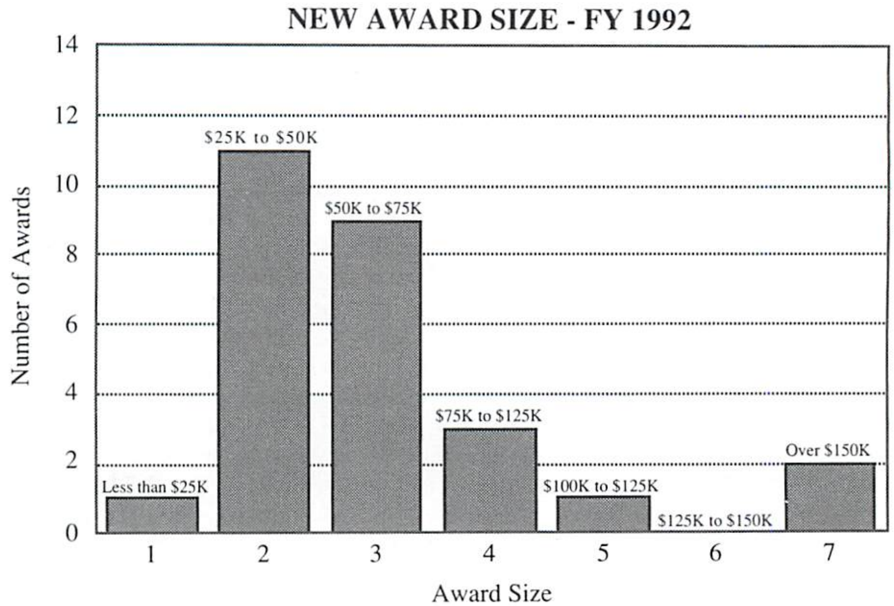


Figure 1

Each proposal was discussed at length on Monday. On Tuesday morning each proposal was briefly reviewed and where appropriate, suggestions were made for narrowing objectives and adjusting budgets to better meet program goals and budget constraints. Each panelist then submitted a rating for each proposal. Following the rating, a ranked list was prepared and adjusted for consistency and balance relative to CEDAR goals.

In the final analysis, 29 proposals were funded. These are listed in the accompanying chart on page 7. Almost all of these proposals were reduced from the original request; some were reduced dramatically and are really study awards to allow a full-blown proposal at a later date. A histogram of the size of the awards is shown in Figure 1. The peak (11 awards) was in the $25,000 to $50,000 range. Only two awards were for over $125,000. This contrasts with FY 1991 when 8 awards were for over $125,000 (see Figure 2). The quality of *all* the proposals was very high. The panel and NSF clearly stretched the number of awardees to the maximum. To do this, the dollar amounts of the awards were quite small. Painfully, numerous very meritorious proposals still had to be declined.

The general considerations for CEDAR funding are scientific merit, responsiveness to stated CEDAR goals, encouragement of new researchers and students, best use of available resources, balance, and long-term benefits to the CEDAR community. These criteria were applied to this year's proposals and will be the principal criteria for the coming years as well.

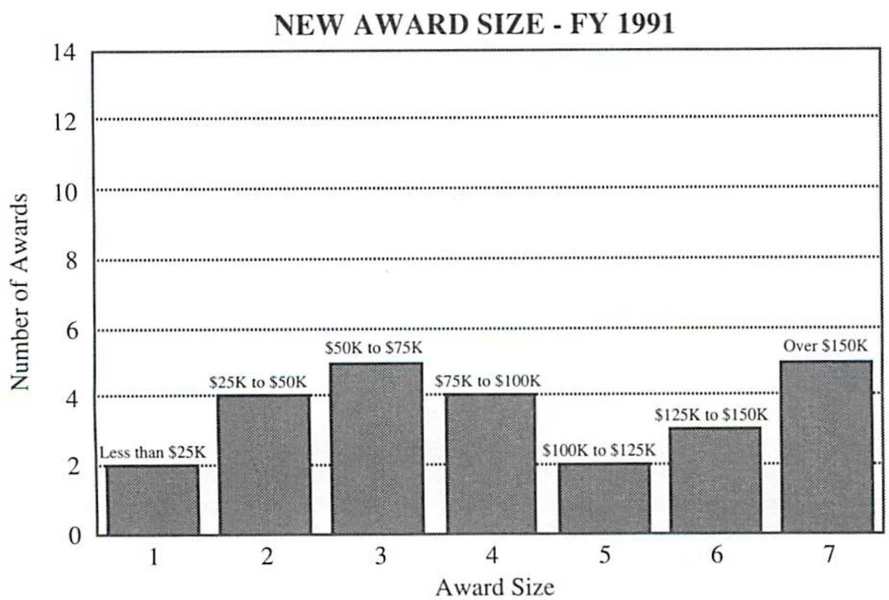


Figure 2

If any criticism could be made in this year's list of awards, I believe it would be that we made too many small awards. This was done for many good reasons, of course. Still, it is a fundamental tenet of the CEDAR program to improve the infrastructure of our research community. Awards of under $50,000 rarely build the community's infrastructure. Hopefully, in FY 1993 we will be able to fund some large and medium-sized infrastructure proposals, as well as innovative small research proposals.

Richard Behnke, NSF

List of New FY 92 CEDAR Awards

Susan K. Avery
University of Colorado
Radar Investigations of Mesospheric and Lower Thermospheric Dynamics at Sondre Stromfjord, Greenland

Odile de la Beaujardiere and Jurgen Watermann
SRI International
Polar Cap Electric Field

Donald T. Farley
Cornell University
Continue Upgrading the Facilities of the Jicamarca Radio Observatory and Add a Peruvian Staff Scientist

Bela Fejer
Utah State University
Coordinated Incoherent Scatter Radar and Fabry-Perot Interferometer Measurements

Cassandra Fesen
Dartmouth
Theoretical Modelling for the MISETA Initiative

John C. Foster and Michael Buonsanto
MIT
CEDAR Storm Study

John C. Foster and Dwight P. Sipler
MIT
A CEDAR Fabry-Perot Interferometer at Millstone Hill

Steven J. Franke
University of Illinois, Urbana
Transmitter and Receiver Upgrade for the Urbana MF Radar Under the CEDAR Program

David C. Fritts
University of Colorado Boulder
ALOMAR: A CEDAR Temperature, Wind and Momentum Flux Lidar for Global Change and Dynamics Studies in the Arctic

David C. Fritts
University of Colorado, Boulder
Equatorial Middle Atmosphere Coupling and Dynamics Using the Jicamarca Radar

Raymond A. Greenwald
Johns Hopkins University
SuperDARN

James Hecht and Richard Walterscheid
Aerospace Corp
CCD Observations of Mesospheric Airglow Emissions: A Follow on to the ALOHA-90 and AIDA-89 Campaigns

Colin Hines and Frank Djuth
Geospace Research Inc
Observational and Interpretative Studies of Middle Atmosphere and Lower Thermosphere Mesoscale Dynamics

Matthew H. Hitchman
University of Wisconsin
Equatorial Middle Atmosphere Coupling and Dynamics Using the Jicamarca Radar

Michael C. Kelley
Cornell University
Operation of the CEDAR Science Steering Committee

John D. Kelly
SRI International
Sondrestrom Data Acquisition and Radar System Improvements for CEDAR

Miguel F. Larsen
Clemson University
Radar Investigations of Mesospheric and Lower Thermospheric Dynamics at Sondre Stromfjord, Greenland

Richard Link and Douglas Strickland
Computational Physics Inc
Analysis of CEDAR Auroral and Airglow Data

Michael Mendillo
Boston University
Imaging Science Component of the MISETA Program

Michael Mendillo
Boston University
Coordinated Imaging and Incoherent Scatter Radar for Ionospheric Research

John Meriwether
Clemson University
Multi-instrumented Studies of Equatorial Thermospheric Aeronomy (MISETA): Fabry-Perot Measurements at Arequipa, Peru

John Meriwether
Utah State University
Mid-latitude Studies of the Middle Atmosphere Using Rayleigh Scatter Lidar

Kent L. Miller
Utah State University
Dynamics and Composition of Intermediate Plasma Layers in the Lower Thermosphere

Stanley Solomon
Colorado
Auroral Emissions Modelling

Douglas G. Torr
University of Alabama Huntsville
A Program to Fabricate a Phase III Class 1 Spectrometric Facility for a CEDAR Observatory

Cesar Valladares
Boston College
MISETA: Evolution of Sub-km Irregularities and their Drifts at Ancon, Peru

Jurgen Watermann and Odile de la Beujardiere
SRI International
Comparison of Ionospheric Joule Heating Rate with Poynting Flux and Energetic Particle Precipitation Energy Deposition

Vincent B. Wickwar
Utah State University
Mid-latitude Studies of the Middle Atmosphere Using Rayleigh and Raman Lidar

Thomas Wilkerson
Maryland
Mid-latitude Studies of the Middle Atmosphere Using Rayleigh and Raman Lidar

New NSF Publications of Importance to The CEDAR Community

The new CEDAR proposal announcement entitled *Global Change Research Program: 1993 Research Opportunities* has just been released and is now being mailed to those on the CEDAR mailing list. The booklet provides a description of the NSF programs for CEDAR, GEM, and SunRISE. **Please note that CEDAR proposals must be postmarked by November 2, 1992**, not October 1 as listed in the brochure. If you do not receive this publication, please contact Dr. Sunanda Basu.

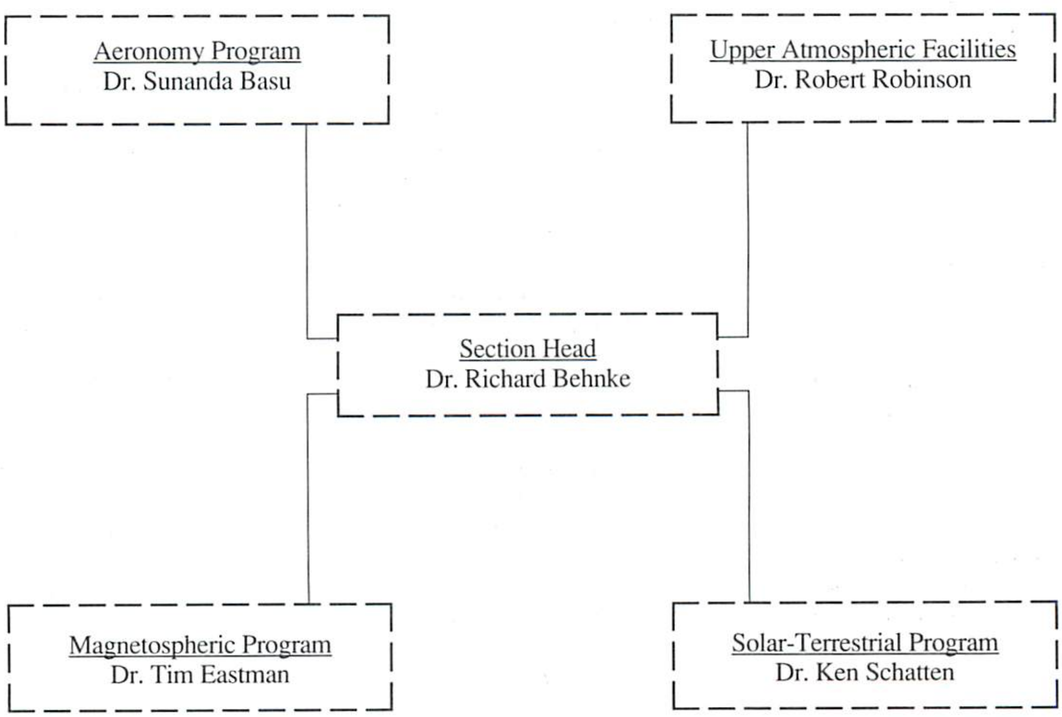
The NSF brochure entitled *Grants for Research and Education in Science and Engineering* (GRESE) has also been updated (NSF 92-89 replaces 90-77) with major changes in proposal formats. It imposes a strictly enforced 15-page limit on the text of the proposal Project Description, which includes results of prior support, and limits biographical sketches to two pages per investigator. This updated GRESE will not be available until after October 1 but can be requested directly through NSF's Science & Technology Information System (STIS) via e-mail (stis@nsf.gov). If you have questions about either publication, please contact Dr. Sunanda Basu, Program Director for Aeronomy, at (202) 357-7619 or via e-mail (sbasu@nsf.gov).

8th Annual CEDAR Workshop Scheduled for June 21-25, 1993

The 8th annual CEDAR Workshop will be held at the National Institute of Standards and Technology (NIST) and at the National Center for Atmospheric Research (NCAR) in Boulder, Colorado, from Monday, June 21 through Friday, June 25, 1993. It will again be followed by the GEM Workshop in Snowmass, which is tentatively scheduled for June 28-July 2, 1993. The CEDAR Workshop committee will be chaired by Craig Tepley and includes Ray Roble, Jim Hecht, and Barbara Emery. The format will be similar to previous meetings with tutorials, a poster session, and workshops. Specific information about the 8th CEDAR Workshop, including tentative agenda and housing information, will be included in the February issue of the *Cedar Post*.

NSF Upper Atmospheric Program at Full Staff

For the first time under its new organization plan, the NSF Upper Atmospheric Program office is fully staffed. A block diagram shows the present configuration. A full complement will relieve the considerable pressure felt by the staff in recent years. This in turn should help reverse the amount of processing time required for grants, which has once again begun to increase after the considerable improvement which occurred in the mid-1980s.



CEDAR Post-Doctoral Awards

The Aeronomy and Upper Atmospheric Facilities Program of the Division of Atmospheric Sciences of the National Science Foundation plans to make a post-doctoral award within the Coupling Energetics and Dynamics of Atmospheric Regions (CEDAR) initiative. The types of studies the successful candidate will be expected to perform include: analyzing existing CEDAR campaign data, taking an active role in an ongoing CEDAR campaign, coordinating the community in helping develop a new CEDAR campaign, developing hardware/software of interest to the CEDAR community of scientists, and developing instrumentation pertinent to CEDAR. The demonstrated abilities to be self-starting and to work independently will be important selection criteria.

The tenure of this award may be at the institution or facility of the applicant's choice. The candidate will be expected to provide a short proposal including a brief (3 pages or less) description of the type of CEDAR-related research to be carried out. In addition to the standard NSF proposal forms, a letter indicating the host institution or facility's interest and commitment to this CEDAR award must be included, along with two letters of recommendation, an abstract of the candidate's doctoral thesis, and a transcript of course work. Applications will be reviewed by the CEDAR Science Steering Committee with a final selection made by the AER and UAF program officers.

The fellowship will be for **two** years at a stipend level of $36,000. per year. An additional amount of approximately $9,000. will be provided toward employee benefits and institutional overhead. If cost sharing possibilities exist at the host institution, through an existing NSF grant, for example, this should be mentioned in a cover letter accompanying the proposal. Such possibilities will not be taken into account in ranking the proposals but may be considered in maximizing the effect of the available resources. All proposals should be sent to either the Aeronomy or Upper Atmospheric Facilities programs by **January 15, 1993**. Questions regarding this award can be addressed to:

Dr. Sunanda Basu
Division of Atmospheric Sciences
Aeronomy Program
National Science Foundation
Washington, D.C. 20550
(202) 357-7619

Dr. Richard Behnke
Division of Atmospheric Sciences
Upper Atmospheric Facilities Program
National Science Foundation
Washington, D.C. 20550
(202) 357-7390

In addition, the High Latitude Observatory offers a two-year post-doctoral position in CEDAR-related topics covering a wide range of scientific disciplines. Experts in theoretical, experimental, or simulation/modeling are encouraged to apply. Applicants must be willing to re-locate to Boulder, CO and work at the HAO. Applications must be submitted by **January 15, 1993** and include a resume, one-page statement of purpose, selected reprints or preprints, and the names and addresses of three references. Submission should be made to:

Dr. Raymond Roble
HAO/NCAR
P.O. Box 3000
Boulder, CO 80307-3000
(303) 497-1562

Chris Hostetler is the 1992 Recipient of the OSA Allen Prize

University of Illinois at Urbana-Champaign graduate student Chris Hostetler was recently named the 1992 recipient of the Allen Prize by the Optical Society of America. During the past several years, Chris has been quite active in a variety of lidar studies related to the CEDAR Program. The Allen Prize was established by the Optical Society of America through an endowment provided by Robert Allen. It is presented annually "to a person who, while a graduate student, has made outstanding contributions to atmospheric remote sensing using electro-optical instrumentation, especially for conceiving and developing new and unique devices, for the development of a new measurement technique or for perceptive analysis of remote sensing measurements." Chris received the award for the gravity wave dynamics studies he is conducting with the air-borne and ground-based Na/Rayleigh lidar data he acquired during the AIDA-89 and ALOHA-90 Campaigns. Chris expects to receive his Ph.D. in electrical engineering later this Fall.

Chet Gardner, University of Illinois

New 1994 Initiative: NSF-STEP

NSF's Division of Atmospheric Sciences seeks your advise in the planning of its only proposed new initiative for FY '94: namely, NSF-STEP. Suggestions of all kinds are welcome, even for its name!

STEP is an international program established under the International Council of Scientific Unions (ICSU) for the 1990-1997 time frame. The scientific goal of STEP is to advance the quantitative understanding of the coupling processes responsible for the transfer of mass and energy between the various regions of the geospace environment from the sun to the middle atmosphere, and to the lower atmosphere. All observational modes are included in STEP with special emphasis on improved utilization of ground-based capabilities and integration of these with space-based observations.

The key theme of the proposed NSF-STEP initiative at the U.S. National Science Foundation (NSF) is that of understanding global integration and large-scale coupling from the sun to Earth's atmosphere through basic research into micro-meso-macro scale physics and ground-based observations which, for certain parameters, can be more effective than spacecraft. NSF-STEP promises to be an important catalyst for basic research in solar-terrestrial science leveraging through STEP an international investment of over $2.5B worldwide over the coming decade.

The NSF-STEP initiative is intended to provide a scientific focus and internationally-based framework for several solar-terrestrial research activities which tend, in practice, to fall outside the framework of the Global Change Research Program and yet are of fundamental scientific interest as well as being important to Earth system science generally. Close ties to NSF's Global Change programs will be maintained (especially CEDAR, GEM and SunRISE), although the focus will be on science projects that will not significantly overlap Global Change activities.

The Upper Atmospheric Research Section of the Division of Atmospheric Sciences manages solar-terrestrial science at NSF and that section includes four programs:

Section Head - Richard Behnke (202) 357-7390; rbehnke@nsf.gov
Magnetospheric Program - Tim Eastman (202) 357-7618; teastman@nsf.gov
Aeronomy Program - Sunanda Basu (202) 357-7619; sbasu@nsf.gov
Solar-Terrestrial Program - Ken Schatten (202) 357-7618; kschatte@nsf.gov
Upper Atmospheric Facilities Program - Bob Robinson (202) 357-7619; rmrobins@nsf.gov
NSF-STEP contacts: Tim Eastman in 1992; Ken Schatten in 1993.

Richard Behnke, NSF
Tim Eastman, NSF

The Burnside Factor: A CEDAR Consensus Standard for the Atomic Oxygen Collision Frequency

The importance of accurate knowledge of the atomic oxygen collision frequency is widely recognized in the upper atmospheric research community since this is a critical parameter associated with ion-neutral coupling in the momentum and energy transfer processes of the earth's thermosphere and ionosphere. Uncertainties in this key parameter affect the results obtained from ionospheric structure models and thermospheric general circulation and electrodynamic models, as well as the derivation of neutral parameters from incoherent scatter radar and ionosonde measurements.

The most commonly used expressions for the atomic oxygen ion-neutral collision frequency have been based on laboratory measurements conducted some thirty years ago by *Stebbings et al.* [1964]. Tabulations and expressions were developed by *Dalgarno* [1964], *Banks* [1966], and *Schunk and Walker* [1973], which, although slightly different in terms of their coefficients and temperature dependencies, follow closely a simplified expression of the form:

$$\nu_{O^+\text{-}O} = 2.3 \times 10^{-17}\,(T_r)^{0.5}\,n(O) \qquad (1)$$

where $T_r = (T_i+T_n)/2$, and n(O) is the atomic oxygen density in m^{-3}. Taking into account electrostatic force effects on particle trajectories, *Stubbe* [1968] recommended an increase of a factor of 1.3 over the coefficient in Eq. (1). For simplicity, we will discuss below various differences in collision frequency resulting from other studies in terms of an approximate multiplicative factor of the coefficient in Eq. (1).

No new experimental laboratory measurements have been successfully made since those by *Stebbings et al.* [1964], because of the difficulty of creating an atomic oxygen ion beam uncontaminated by metastable species. Even the *Stebbings et al.* measurements are not considered to be accurate to better than a factor of 2 because of this problem. Moreover, laboratory measurements are generally made at high energies and need to be extrapolated to ionospheric thermal energies below 1 eV, although theoretical models are generally adequate to carry out these extrapolations. Although several attempts are planned at various institutions to conduct these difficult laboratory measurements, results are not expected for several years.

A growing body of indirect experimental evidence has been accumulating that indicates that the coefficient in Eq. (1) should be increased. *Roble* [1975] was able to match results of a one-dimensional ionospheric model with the diurnal variation of electron density observed at Millstone Hill by increasing the collision frequency represented by Eq. (1) by a factor of 1.5. *Carlson and Harper* [1977] computed a factor of 1.3 by combining Arecibo observations with satellite density measurements. The issue of the atomic oxygen collision frequency remained relatively dormant for about a decade, until *Burnside et al.* [1987] determined a factor of 1.7 (+0.7,-0.3) by combining Arecibo incoherent scatter radar (ISR) measurements of ion drifts and Fabry-Perot Interferometer (FPI) measurements of neutral winds. Similar co-located ISR and FPI observations at Millstone Hill [*Sipler et al.*, 1991; *Buonsanto et al.*, 1992], and at Sondrestrom [*Christie*, 1990] suggest a factor of 1.7 to 1.9.

Recent theoretical computations based on potential energy curves have also yielded new results for the atomic oxygen collision cross-section. The theoretical computations by *Stallcop et al.* [1991] indicate a factor of 1.3, although revised theoretical computations by Dalgarno (private communication, 1992) suggest a factor of 1.9 is more appropriate. At present, preliminary results from *Omidvar et al.* [1992] suggest a factor of 1.7 at a temperature of about 500K, but deviate to lower factors at higher temperatures.

The CEDAR working group on the Coordinated Analysis of the Thermosphere under the leadership of Dr. Maura Hagan recognized the importance of a standardized value for the atomic oxygen collision cross-section and reviewed the available literature at a workshop held at MIT's Millstone Hill radar site in April, 1992. While awaiting new and reliable laboratory measurements to be obtained and refined theoretical computations to be developed, the group proposed an interim standard at the CEDAR Workshop in Boulder in June, 1992. Community consensus was obtained for a factor of 1.7 with an uncertainty of ±10%. In a tribute to Roger Burnside, who revived interest in this important parameter through his seminal paper in 1987 which proposed the value of 1.7, the factor has been named the "Burnside factor".

Although the above discussion was centered around "factors" relative to the collision coefficient expressed by Eq. (1), there are indeed slight differences between the parameters [*Dalgarno*, 1964; *Banks*, 1966; *Schunk and Walker*, 1973] which various studies used to normalize their results and derive this factor. Although the variation of the collision frequency with temperature differs slightly between these formulations, the uncertainty in the coefficient more than overshadows the difference in the temperature dependencies. To avert any further confusion regarding the value which the "Burnside factor" must multiply, we write directly the recommended CEDAR consensus equation for the atomic oxygen collision frequency as:

$$\nu_{O^+-O} = 4 \times 10^{-17} (T_r)^{0.5} n(O) \qquad (2)$$

where $T_r = (T_i+T_n)/2$, and n(O) is in m^{-3}.

A brief journal paper is in preparation to document and justify the above consensus in more detail and to disseminate the consensus widely to the upper atmosphere research community at large.

Joseph E. Salah
MIT Haystack Observatory

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The Cedar Post is published quarterly and mailed to more than 800 scientists worldwide.
M. C. Kelley, Editor.
L. Shelton, Production Manager.