The Cedar Post

March 1993 No. 18

CEDAR in Puerto Rico: The Arecibo Observatory Upgrading

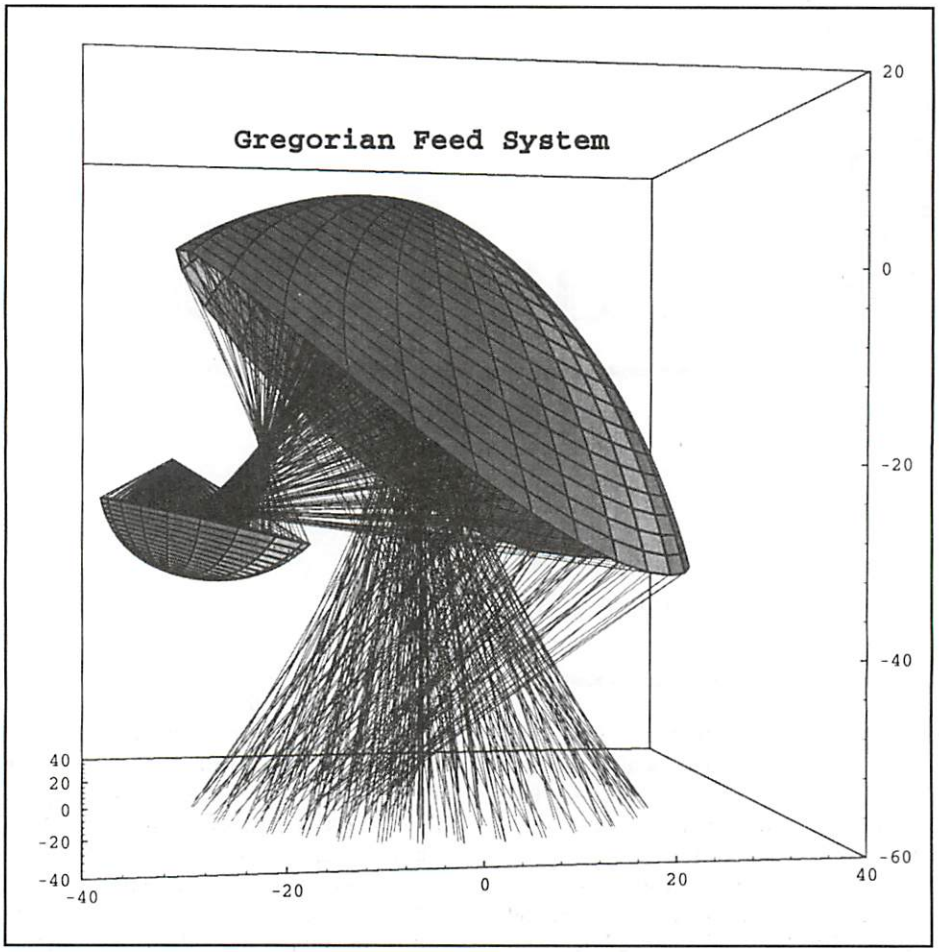
The 1000-foot diameter Arecibo instrument has been a mainstay of both atmospheric and astronomical research for almost thirty years. Located at 66 degrees west longitude and 18 degrees north latitude, Arecibo is a vital link in the Western Hemisphere chain of incoherent scatter radar systems extending from Peru to Greenland. The magnetic dip angle at Arecibo is about 50 degrees, making it a mid-latitude ionospheric observatory. The National Science Foundation supports the National Astronomy and Ionosphere Center (NAIC) as one of four National Centers, through a Cooperative Agreement with Cornell University. As such, use of the facility is available to all researchers nationwide, based on peer review of research proposals. NASA provides additional support for planetary radar studies. Located about one half hour south of the coastal city of Arecibo, about two hours west of San Juan, the facility provides on-site accommodations for visiting research teams.

History

Bill Gordon, while a professor of Electrical Engineering at Cornell University, initiated the project and obtained funding support from the DOD Advanced Research Projects Agency in the late '50s. He and Merle Lalonde, the project manager, led the initial construction effort to a successful conclusion in 1963. Operation under DOD funding continued through the late '60s, but this became problematic following the Mansfield amendment in 1968 which limited the role of the Defense Department in support of basic research. Frank Drake led a successful effort to transfer sponsorship to the National Science Foundation, and to obtain the funds from NSF and NASA for a major upgrading of the facility in the early '70s. This upgrade, completed in 1974, provided a much more accurate reflector surface and included the installation of an S-band transmitter for planetary radar work. Following the upgrade, operations which were previously restricted to frequencies well below 1 GHz were extended to 5 GHz. Also in the '70s, a High Frequency Heating Facility was added about 10 miles north of the main site. This system uses four 200 KW transmitters operating between 3 and 10 MHz to deposit energy in the ionosphere in a thin layer near the critical frequency. The resulting ionospheric modification can be monitored by both the 430 MHz incoherent scatter radar system and a variety of optical instruments located near the radar. A 100-foot diameter telescope is located about 8 miles north of the main site, and has been used, among other projects, to observe scintillation of radio sources through the heated volume and as a bi-static radar receiving site for S-band stratospheric scattering studies. Beginning in the late '60s, various optical facilities have been added to complement the radar facilities. The latest optical system, funded by the CEDAR Program, is a solid state lidar which came into operation in 1990.

Radar Facilities

The 430 MHz Incoherent Scatter Radar system was installed as part of the original equipment at the Observatory. It uses a pair of DEW line klystrons to generate up to 2 MW peak power, 150 KW average power, with duty cycles up to 6 percent. The 96-foot long line feed illuminates the entire 1000-foot diameter reflector, making it by far the most sensitive system at zenith. However, this comes with some disadvantages. Line feeds correct for spherical aberration by correctly phasing the transmitted (or received) signal as a function of radius. Phasing methods are inherently frequency sensitive, the more so the larger the illuminated aperture. Hence, the 430 MHz feed has a full bandwidth between -3 dB points of only 10 MHz, which makes plasma line and other wideband applications difficult. In addition, the sensitivity



drops off and the system temperature increases as the feed is tilted away from zenith to study horizontal wind velocities in the ionosphere. Nevertheless, this system continues to be the mainstay of atmospheric research at Arecibo. Carriage House 1, which supports the feed and receivers, will be retained as part of the Gregorian Upgrading described below.

The 450 KW S-band transmitter, though designed primarily for planetary radar work, has been used quite successfully for atmospheric studies. The 2380 MHz transmitter operates in CW (continuous wave) mode only, but can be phase modulated at a rate up to 10 MHz. This provides extremely high resolution (up to 15 m) for stratospheric turbulence studies when used in combination with the 100-foot Higuialles telescope for bistatic experiments. The S-Band transmitter has also been used for some ionospheric modification studies.

A 47 MHz radar system has been added to the telescope during the past decade. Its feed is collinear with the 430 MHz line feed, so that both radars look at a common volume. While of modest power (1 KW average), it has served as a useful probe of the mesosphere and stratosphere.

On many occasions additional instruments have been brought to Puerto Rico by visiting scientists, often in support of very extensive projects. In 1989 Colin Hines organized Project AIDA, the Arecibo Initiative in Dynamics of the Atmosphere, to study various approaches to measuring winds in the middle atmosphere. During this past summer there was an extensive program of CRRES rocket launches. Most rockets were directed through the heated volume created by the HF facility, from the north coast of Puerto Rico.

The Gregorian Upgrading Program

NAIC is presently engaged in a $24 M upgrading program, which will greatly improve the performance and flexibility of the Arecibo instrument. Funding has been provided in approximately equal amounts from NSF and from NASA. The first phase, improvement of the reflector surface, has been completed. The resulting 2.3 mm rms setting of the surface promises good performance to at least 8 GHz, with still further improvement possible in the future. However, this potential cannot be realized with line feeds. The solution is the Gregorian subreflector system.

Already in 1960 studies were carried out during the design phase for the possible use of a subreflector to correct for the spherical aberration of the primary reflector. The studies demonstrated the feasibility, but correctly stated that the resulting illumination pattern would be edge-brightened by

more than a factor of 10; effectively, the transmitting and receiving aperture would be an annulus rather than a filled aperture. During the late '70s Frank Drake initiated further inquiries into the possibility of subreflector illumination, and this was carried on in more detail by his successor as NAIC director, Tor Hagfors. These studies have shown that dual subreflector systems, consisting of a secondary and tertiary reflector, can provide the control of the aperture illumination that is needed. The design developed by Per-Simon Kildal, a consultant to NAIC, for the Gregorian Upgrade provides very high efficiency and eliminates the frequency dependence and losses inherent in line feeds.

The frequency range covered by the Gregorian subreflector system is limited at the high end only by the (present) 2.3 mm rms of the primary reflector to about 8 GHz, and at the low end by the size of practicable feed antennas for the tertiary to about 300 MHz. In between these two limits, continuous frequency coverage is possible, limited only by the normal constraints of feeds and receivers. To support this additional flexibility, a feed turret 17 feet in diameter is located at the focal point. It can rotate any one of eight to ten feeds into position on command from the control room, making operation of the system at least as flexible as at present, but with much greater frequency coverage. Elimination of the forty-foot long slotted waveguides, and better control of the illumination pattern, promises to permit state-of-the-art system temperatures, perhaps as low as 20 Kelvin in the L-band and S-band frequency ranges. The improved illumination will provide more than 10 K/Jy (about 30,000 square meters effective aperture). In addition, the far field pattern will be much improved, with elimination of the -10 dB ring lobe which is inherent in line feeds.

An added advantage comes from the practical requirement that the 65-foot secondary and 24-foot tertiary be enclosed in an aerodynamic shell capable of surviving hurricane winds. This space frame is 83 feet in diameter and over 50 feet high, with an exit pupil only 43 feet across. Unlike a radome, none of the rays pass through the dome, so it will be covered with sealed aluminum panels except for the exit pupil. This will eliminate direct access to the feed for interfering signals or ground clutter arriving from the horizon; at worst they will scatter off the support structure and enter through the pupil. This should provide a significant improvement in the RFI environment at Arecibo.

The present S-Band radar will be replaced by a 1 MWatt transmitter, to be housed in the feed tower. This doubling of the transmitter power, when coupled with the improvements in aperture efficiency, system temperature, and high zenith angle performance will provide improvements of a factor of 10 to 40 for various planetary radar targets. A critical part of this improvement comes from a new ground radiation shield being installed around the circumference of the primary reflector. This shield, fifty feet high and over 3,000 feet long, is tilted back from vertical by 25 degrees. In this way observations at high zenith angle see cold sky rather than the 300 K ground radiation. Together with a 47-foot offset designed into the Gregorian illumination pattern this nearly eliminates increases in system temperature at high zenith angles. These increases are presently more than 3 dB in many of the best receivers, so this improvement opens the way for much more sensitive measurements. The ground screen will also improve performance of the 430 MHz line feed away from the zenith.

Operation of the 430 MHz transmitter with the Gregorian subreflector system was not originally included as part of the Upgrading project. However, a recent promise of support from the NSF Atmospheric division will make it possible to extend the slotted waveguide for the 430 MHz transmitter up the Gregorian side of the feed arm and down into the feed cabin, to a specially designed transmitting feed. By use of a waveguide switch installed for the CRRES campaign, users will have the option of switching the power back and forth between the line feed and Gregorian, or splitting the power between the two. This has the potential of reducing the time required to obtain cardinal point wind velocities during World Day operations. In addition, the performance of the Gregorian at the large frequency offsets of the plasma lines will permit more accuracy in this type of measurement.

Schedule

The upgrading program is now in progress. The ground screen panels with their 1/4-inch stainless steel mesh are presently being assembled in Arecibo and will soon begin to be placed on their support frames around the dish. A contract for the structural upgrading is being let at this time, and the draft RFP for the S-Band transmitter is at NSF for review. The pacing item is the structural upgrading. The suspended structure weight will be increased from 600 to 900 tons, of which 90 tons is the weight of the new feed tower, subreflectors and equipment. In order to support this additional weight safely, twelve new cables will be added to the 27 presently in place. The new main cables will extend, not to the near corner of the triangular platform, but to points two-thirds of the way down towards the far corners. The additional torsional stability of this arrangement will assist in improving the dynamic rigidity of the structure. This is part of the improvement needed to increase the pointing accuracy to 5 arcseconds, which corresponds to 1/8 inch at the focal point. An additional improvement comes from the plan to actively control the tension in the tiedown cables to maintain the corners of the platform at a fixed height to about 1 mm accuracy, independent of the temperature and of the load distribution on the platform.

The contractor will require 21 months following signing of the contract, leading to completion in late 1994. At that point NAIC will begin the commissioning phase of the upgrade project. This includes such mundane items as running power and control lines into the feed tower, but also major items such as installation of the new S-Band transmitter, calibration of the pointing and gain characteristics and derivation of new models for their application, and installation and testing of the new Monitor and Control system. A great deal of new instrumentation, including feeds, receivers, IF, LO, and fiber optic systems are planned as part of the upgrading. The venerable Harris computers will be replaced with VME systems running the VxWorks real time operating system. Data acquisition will be supported with a new high speed

version of the Radar Interface, a set of four 12-bit A/D converters running at rates up to 10 MHz and with built-in support for packing of 1-, 2-, 4- and 8-bit samples, in addition to sign-extended 12-bit samples. Accurate control of synthesizers and of data acquisition sequencing also makes up part of the data acquisition work. A new correlator and planetary radar decoder will be based on VLSI chip development undertaken in cooperation with the NASA VLSI Design Center at the University of New Mexico in Albuquerque.

Limited operation will be possible through much of the upgrading period and a call for proposals is described on page 5 of this CEDAR Post issue. The contractor will have first rights to telescope time, but operation on nights and weekends will be possible, though with limited pointing and steering capabilities. Following the completion of the contractor's work and during the commissioning period, priority will be given to getting Carriage House 1, with the 430 MHz ISR feed, back into full operation.

The Arecibo Observatory operates on a peer-reviewed proposal basis. It is very heavily subscribed for both atmospheric and astronomical observations, with a typical lead time of 8 to 18 months between proposal and scheduling on the telescope. In anticipation of still higher proposal pressure following the upgrading, plans are being made to change over to a "deadline" mode in which proposals will be acted upon within a well-defined fixed period of time. Proposals for use of the telescope prior to completion of the upgrade may be submitted now, though there is already a fairly large queue. There is no charge for use of the facilities, and modest travel support is available for those without other funding for research travel.

Michael M. Davis, Arecibo Observatory

Call for Atmospheric Sciences Proposals for the Arecibo Upgrade Period - Due April 16, 1993

Proposals to use the Arecibo Facilities during the period when normal operations will be restricted due to construction activity (approximately the 12 months, mid-93 to mid-94) are solicited by **April 16, 1993** to help maximize scheduling efficiency. Proposals for the following modes of operation for the radar should be submitted:

a. Motion in both axes but with limited pointing accuracy
b. Restricted or no motion in either ZA or AZ
c. No motion

Observing will be dependent on the detailed construction schedule which is not yet finalized. Furthermore, observations will not take place during upgrade working hours (daytime for 5 or 6 days per week). Most of the time will be restricted to the 430, 318, 130, and 47 MHz systems. Detailed information about the construction schedule and other particulars related to observing possibilities will be updated regularly and will be available via anonymous ftp.

Anonymous FTP Instructions:

ftp aosun.naic.edu (or ftp 192.65.176.4)
username: anonymous
password: <your name>
cd pub/upgrade
get README
quit

Then consult the README file for more information.

Craig Tepley, Arecibo Observatory

Call for Afternoon CEDAR-93 Workshops

Now is the time to think about the afternoon workshops at the next CEDAR meeting in June, 1993. If you are interested in organizing a workshop, we need from you a title, a brief description of the topic, the number of hours needed for the workshop, an idea of the possible number of people you expect will attend, and any comments about scheduling such as desired days and conflicts to avoid. We expect about 275 people attending the CEDAR meeting, about half of whom are students. We are considering the merits of more, smaller workshops, perhaps at more than one location, in place of three large workshops each afternoon at a single location. This will necessarily entail more overlap of interests. Please comment if you have an opinion.

During previous CEDAR meetings, we have noticed a growing tendency for these afternoon workshops to be styled more along the format of an AGU meeting. That is, formal presentations follow one right after another. While such a formal structure may have its place among mature studies, we feel that this mode of interaction discourages an active participation among those attending. Consequently, we would like to suggest that the individual organizers consider a framework for their workshop which is more informal and highly interactive. We realize that this may be difficult to do in some cases and are not excluding a formal structure preference of the organizers. However, we would like to see a return to one of the original intents of these CEDAR meetings: to have a forum that encourages a lively involvement.

Please contact Craig Tepley no later than **April 30** with your workshop suggestions or comments. [Phone: (809) 878-2612, FAX: (809) 878-1861, e-mail: craig@naic.edu]

Barbara Emery, NCAR

Call for Poster Papers: CEDAR 1993

Last year there were 52 posters, 41 of which were presented by students. As occurred last year, there will be prizes for the best student posters. Poster space is 4 feet tall by 3.5 feet wide. There are two poster sessions scheduled: one at the NCAR Mesa Lab just before and during the reception late Monday afternoon, and one at NIST late Wednesday morning. There will be no preview poster sessions. Please indicate on the registration form if you plan to submit a poster, and send a title and list of authors by **May 31** to:

Dr. James Hecht
Aerospace Corporation
M2-256, P. O. Box 92957
Los Angeles, CA 90009.
Phone: (310) 336-7017
FAX: (310) 336-1636
e-mail: dirac2::hecht (SPAN).
hecht@dirac2.dnet.nasa.gov

Please note whether or not the first author is a student.

Barbara Emery, NCAR

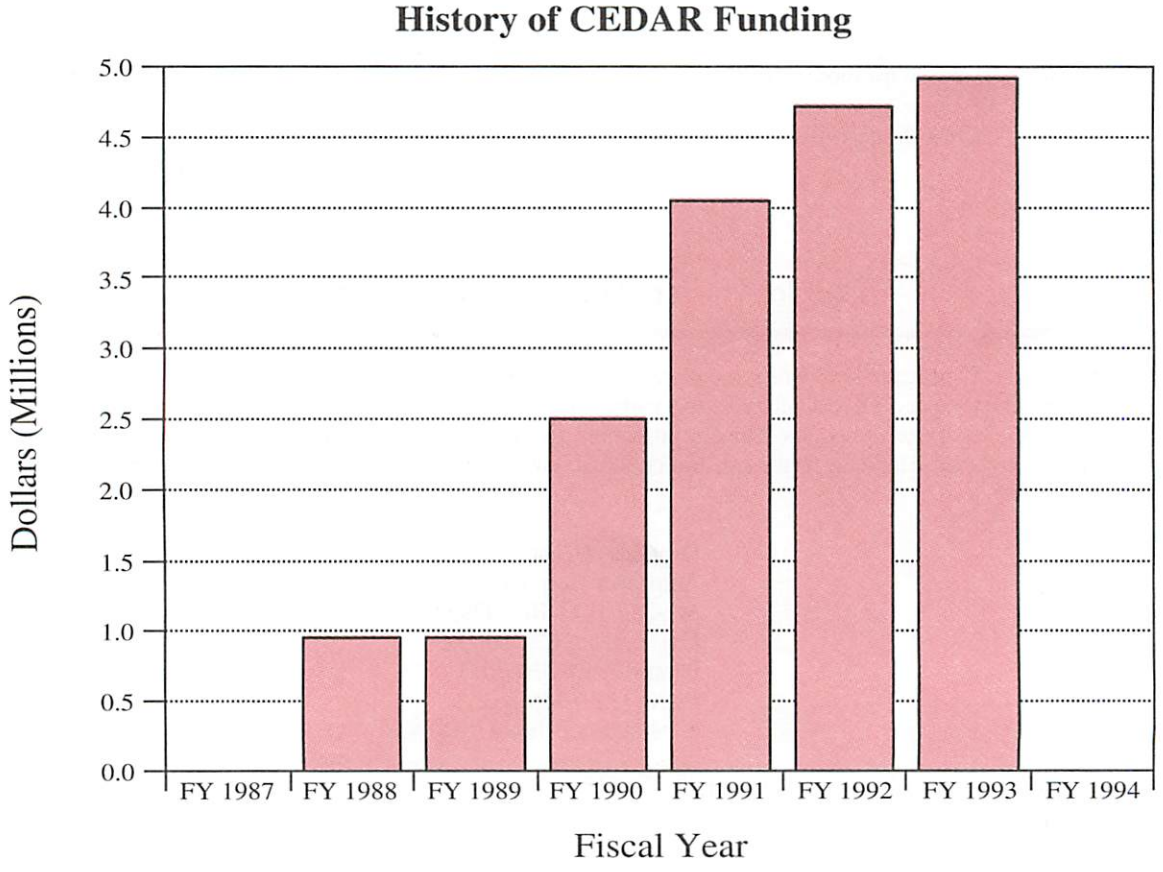
CEDAR After Five Years: An Assessment and a Celebration

Dr. Robert Robinson, Program Director of the Upper Atmospheric Facilities Program, has offered to be the focal point for a compilation of the results and accomplishments of the CEDAR program. CEDAR awards have now been made by the National Science Foundation for five consecutive years with the 1993 selections nearing completion. A large increase in funding has taken place over this time (cf. figure) and approximately $18 M has been awarded through FY92. As we celebrate the tenth anniversary of the combined GBOA/CEDAR effort in Boulder this June, we hope that the responses to this request for information will be helpful in gauging our success and articulating our future goals. In these highly competitive times it is crucial that we be able to convince our scientific colleagues of the worth and promise of our studies. To accomplish this review, we are soliciting the assistance of past and present CEDAR awardees. If you have received a CEDAR award, we ask that you write a short letter giving the title and duration of the award(s) along with a description of the accomplishments resulting from your award(s). This should include scientific achievements, instrument development, papers published, and students supported. It would also be of interest if you included information about the present status of students and post-docs who were supported by CEDAR. Only accomplishments directly facilitated by your CEDAR award should be included and please confine your responses to work already completed. Progress on a current award can be included if it represents a well-defined milestone in the overall project. Also, please feel free to comment on the work of any colleague that you feel is particularly worthy of mention just in case he or she may be too modest.

Please respond by **April 15, 1993** to:

Dr. Robert Robinson
Atmospheric Sciences Division
National Science Foundation
1800 G Street, N.W.
Washington, D.C. 20550

Robert Robinson, NSF



The Middle Atmosphere Research Initiative: A Proposed NSF Program

It could be said that compared with the lower and upper atmospheric regions, the middle atmosphere represents the "last frontier" in atmospheric studies. One of many reasons this is so is that hitherto, instrumental technology, whether ground-based or space-borne, could not be applied to study the chemistry and dynamics of this region. Rocket sounding flights tend to be expensive with poor sampling of climatology. Balloon flights generally do not reach the altitudes needed. Low sensitivity created by the lack of clear air turbulence for the region between 30 and 70 km made radar systems generally unable to observe middle atmospheric winds in this "gap". Moreover, lack of visible airglow emissions renders passive spectroscopic techniques ineffective for altitudes below 80 km. This problem of access, however, changed almost overnight with the introduction of sophisticated lidar systems. These powerful and effective tools may be used to observe profiles of wind, temperature, and species concentration throughout the middle atmospheric region with high accuracy. Furthermore, the successful flight of the NASA/UARS satellite and observations of middle atmospheric trace species by limb scanning instruments flown on the Shuttle have produced a variety of measurements, sparking renewed interest in this field. Exchanging total lack of data for the new influx of results from ground-based lidars and space-borne remote sensing instruments has created many new questions.

Coupled with the push emanating from changes in sensor technology is the realization of the serious impact Man's activities have had or could have upon the middle atmosphere's environment. Because radiation coupling between the Earth's surface and the Earth's cloud cover does not apply to the middle atmosphere, it appears that the middle atmosphere serves as a more accurate leading indicator for climatic changes than the lower atmosphere. Consequently, it is predicted that the middle atmosphere will become colder, wetter, and cloudier during the next century. Recent middle atmospheric observations combined with needs of global circulation models designed to forecast the impact of global change have created a pressing demand for improved modelling of the chemistry, radiation, and dynamics of the middle atmosphere. Selected requirements, among many, include new laboratory chemistry studies, improved knowledge of solar absorption cross sections, and new comprehensive field studies of the kind supported by national and international coordinated efforts in lower and upper atmospheric research. Major qualitative and quantitative improvements in our fundamental understanding of the middle atmosphere can be achieved only when the approach to these problems follows a closely integrated strategy using state-of-the-art instrumental facilities and sophisticated numerical models of middle atmospheric dynamics and chemistry. Institutional response to satisfy these needs has been hampered by the lack of funding resources for research bearing on these new problems.

The need for support in middle atmospheric science surfaced in a recent review of long range plans carried out by the Advisory Committee on Atmospheric Science in response to a request by Dr. Eugene Bierly, the former Division Director of Atmospheric Science at the National Science Foundation. Three separate proposals relating to specific middle atmospheric themes presented by NSF program directors were combined to form the Middle Atmosphere Research Initiative. A vote taken among program directors and ACAS panel members showed that MARI received the second highest rating out of the fifteen competing initiatives. Consequently, the aeronomy and atmospheric chemistry programs at NSF jointly sponsored a workshop meeting held at NCAR on November 30 - December 1, 1992. A group of about 35 scientists met to review the science priorities of middle atmospheric science. This effort marks only the first of many steps toward the development of a newly funded initiative. However, considering the history of CEDAR, one sees how the pattern of "top down" initiation can be transformed into the more desirable thrust of a "bottom up" program in which competition of ideas among consortia of scientists serve to select those areas in need of support. A similar development is likely to emerge for the future of MARI.

It was apparent that two separate communities were meeting for the first time. One represented the thrust led by NASA with significant support by NOAA and NSF that had focused its efforts upon the lower stratospheric region with the primary purpose of understanding the ozone depletion problem. This community has been active for nearly two decades with participants drawn from the areas of meteorology and atmospheric chemistry. The other community was composed of CEDAR scientists investigating mesospheric and lower thermospheric aeronomy. Clearly, one of the many MARI program strong points will be a union of these two communities with an integrated approach utilizing the capabilities of each community. After some general discussion the workshop group separated into three major contingents of scientists to develop MARI science priorities for three key areas: chemistry and radiation, dynamics, and coupling. Subsequently, the group leaders presented to MARI participants lists of specific topics singled out in these sessions as being key to continuing progress in these sub-fields of middle atmospheric research.

The chemistry/radiation group advocated that part of MARI's focus be directed to key areas given less emphasis in previous initiatives or possibly requiring a more active collaboration with researchers having broad interests in several atmospheric regions. Areas identified concerned chemical processes related to the middle atmospheric energy budget, improved data on the distribution of the spectral solar flux with altitude, and improved photochemistry codes for minor constituents. Chemical reaction rates continue to need much attention. The parameters of absorption cross sections, quantum yields in reactions, quenching rates, energy transfer rates, and radiative lifetimes are particularly important. Of great importance is the topic of heterogeneous reactions, which is the key to understanding catalytic cycles not only in the polar region, but also on a global scale.

The dynamics group had more difficulty in determining priorities. The needs are paramount for small and large scale processes alike. Our fundamental understanding of wave dynamics such as gravity waves, planetary waves, and tides still remains poorly quantified. The coupling of these phenomena with the dynamics of the polar vortex and the equatorial large scale dynamical structures remains an unsolved challenge. The role played by the linking of these dynamical processes with the mesospheric global circulation system remains to be clarified but certainly pertains to the extremely low temperatures observed in the summer mesospheric region. The third group invoked the familiar coupling theme which applies to many MARI science themes. Coupling between atmospheric regions exchanges energy in complex ways that must be understood. Coupling emerges in a variety of forms, including dynamical, radiative, chemical, and electrodynamic modes. These all have major effects upon the chemistry and dynamical balance of the middle atmosphere that remain to be clarified in detail.

The work of quantifying the needs of a new research initiative in middle atmospheric science as started by this workshop is only just beginning. Much more remains to be done. The emphasis in this workshop concerned developing the science priorities needed for future middle atmospheric studies. Lack of time prevented discussion on instrumental requirements needed to expand the sparse data base currently existing or how to address what network of sensors might be needed to follow the climatology, production, and dissipation of middle atmospheric dynamical processes. Doppler lidar and radar systems will surely play a critical role in future MARI activities. A strong plea was made to use existing data in the form of a readily accessible data base as a part of an integrated MARI plan for the future. Furthermore, the need for student and post-doctoral associate involvement in the MARI initiative was stressed. The MARI report is available in draft form from Dr. Guy Brasseur, NCAR, and comments and contributions are invited. A summary of the MARI report presented to ACAS on January 5, 1993, was well received by panel members, who provided encouraging support.

John W. Meriwether, Clemson University

Atmospheric Sciences Position
National Astronomy and Ionosphere Center at Arecibo Observatory

The NAIC, headquartered at Cornell University, invites applications for a postdoctoral research associate position in the area of atmospheric sciences at the Arecibo Observatory in Puerto Rico, beginning in the late summer or fall of 1993. This two-year appointment may be renewable for an additional year. Applicants should have a doctoral degree and the ability to pursue an independent research program. The Observatory is a national center for research in atmospheric science and radio and radar astronomy. Facilities for atmospheric research at Arecibo include a high-powered HF ionospheric modification facility, the 430 MHz incoherent-scatter radar, a co-aligned 50 MHz radar, a bistatic 2380 MHz radar for tropo/stratospheric studies, and extensive optical instrumentation including a recently installed Doppler Raleigh lidar. A major NSF/NASA-supported upgrading of the 305 m telescope, including a dual-beam capability for the 430 MHz incoherent scatter radar which will make very substantial improvements in its performance, is currently in progress. With a total staff of about 130, 14 scientific staff members, and numerous visiting scientists, the Observatory offers an attractive interdisciplinary research environment with generous support for travel, computing, and other research needs.

Major areas of research in atmospheric sciences at the Observatory include: studies of exospheric composition and structure; electrodynamic coupling of the ionosphere-thermosphere system; detailed studies of HF-produced plasma instabilities and consequent effects on ionospheric plasma; simultaneous observations of the general circulation of the thermosphere in a major collaborative effort with other facilities worldwide; optical and radar studies of mesospheric and lower thermospheric dynamics; and studies of turbulent layers in the stratosphere and troposphere, including the effects of thunderstorms. Each year more than 200 visiting scientists conduct their research at the Observatory in addition to the investigations carried out by the on-site staff, which includes six atmospheric scientists. Apart from conducting their own research programs, the staff are expected to aid visiting observers and to help define and implement improvements in equipment and procedures.

Applicants should include a resume, the names of three individuals for references, and a statement of the type of research activity you would anticipate undertaking at Arecibo. The revised deadline for applications is **April 5, 1993**, although consideration may be given to applications received after this date. Applications should be sent to: Office of the Director, NAIC, Cornell University, Space Sciences Building, Ithaca, NY 14853-6801. NAIC is operated by Cornell University under a cooperative agreement with the National Science Foundation. EOE/AAE.

Paul Goldsmith, NAIC

1993 Annual CEDAR Meeting Plans

A preliminary agenda for the CEDAR meeting is given on page 11. There will be a reception Monday evening at the National Center for Atmospheric Research (NCAR) on the mesa. Similarly, Wrangler 2 will be catering a barbecue for us there on Wednesday evening. The morning sessions will be held at NIST, and the afternoon workshops either at NIST, or NCAR on the mesa or the Foothills Lab. A single poster session is scheduled for Wednesday morning. If there are many posters, a second one will be scheduled. The meeting will be held Monday, June 21 through Saturday, June 26 in Boulder, Colorado, immediately preceding the GEM meeting in Snowmass, Colorado (June 28 -July 2, 1993).

This is the tenth year of the CEDAR concept (originally GBOA). In celebration, we will have some retrospective talks during the plenary sessions. We will also have a special session on findings from the UARS program as well as a number of tutorial and topical presentations.

This year, Jeff Forbes is organizing a Data Analysis School on Saturday, June 26 to be held at the National Institute of Standards and Technology (NIST) at the end of the meeting. This school will emphasize the analysis of time series data with gaps. The intent is to give each speaker the same data set and look at the different techniques of analysis. Some topics to be considered are: digital signal processing, spectral methods, Fourier techniques, FFT's, periodograms, non-stationary time series (like 2-day waves), wavelets, and curve fitting. A tentative schedule is listed on page 10.

Barbara Emery, NCAR

Nominations Requested for the 1993 CEDAR Prize Lecture

The CEDAR Prize Lecture was established in 1989 to recognize outstanding scientific contributions to the CEDAR Program. Selection is based upon a research paper either presented, submitted, or published during the past year. The candidate will present a special 30-minute lecture at the 1993 CEDAR Meeting. Previous CEDAR prize lecturers are:

1989 - Art Richmond, *Assimilative Mapping of Ionospheric Electrodynamics*
1990 - Mike Mendillo, *The Discovery of a Sodium Magneto-Nebula Around Jupiter*
1991 - Craig Heinselman, *Sondrestrom MUSCOX - Capabilities and New Results*
1992 - Colin Hines, *The Doppler Spreading Theory of Gravity Wave Spectra*

Nominations for this year should be submitted by **April 30** to:

Dr. Michael C. Kelley
318 Engineering & Theory Center
Cornell University
Ithaca, NY 14853.
Phone: (607) 255-7425
FAX: (607) 255-6236
e-mail: mikek@magneto.ee.cornell.edu

Barbara Emery, NCAR

Graduate Students and Travel Grants for CEDAR 1993

All students from US or foreign institutions attending the CEDAR meeting will have their registration fees waived. A list of students, their interests, and graduation dates will be distributed at the meeting. A bulletin board will be provided for job or general announcements. Students will introduce themselves to the community during the first session on Monday morning.

NSF has provided money for travel and per diem for students from US institutions or foreign universities who will be visiting a US institution during the summer and so will have a US sponsor. Preference will be given to graduate students, but involved undergraduates are also welcome. Applications for travel funds must be received by **April 15**. Students will receive their per diem payment after the meeting and must make their own lodging arrangements.

Professional Travel in Denver will make airline reservations for students travelling from cities where the government rate to Denver is cheaper than the early reservation Saturday stayover rate. At the moment, these cities are: Boston, Cincinnati, Dallas, Dayton, Detroit, Houston, Los Angeles, Pittsburgh, Salt Lake City, San Francisco, Spokane, and Tucson. If you are flying from one of these cities, contact Cindy in the Groups Department of Professional Travel at (800) 333-6338 or (303) 488-0570 to make airline reservations after May 1. Students travelling from other cities are responsible for getting their own tickets for a Saturday night stayover (either June 19 or 26) and will be reimbursed after the meeting. Students flying from Seattle can choose either way since the prices are equivalent.

Students who drive will receive $0.28/mile or the equivalent airfare, whichever is smaller. The per diem (which includes meals, lodging and miscellaneous) is currently set at $20 per day, or $140 for 7 nights stayover. If there are extra funds, the per diem will be increased up to $25/day.

Last year 128 students had their registration fees waived and 116 received travel assistance. The "Application for Student Financial Support" on the back of the registration form requires the signature of the research advisor. This form should be received by **April 15** to be considered for support, but all students should fill it out in order to be included on the list of students, their interests, and their advisors which will be available at the meeting. Please send these forms to Dr. Barbara Emery at the address shown on the registration form.

Barbara Emery, NCAR

1992 CEDAR Workshop Video Tapes Still Available

Copies of the notes from the 1992 CEDAR tutorials and short courses have been available since late summer. The videos were edited and copied to 5 separate tapes at a cost of $75 per set for NTSC, and $200 per set for PAL or SECAM. Copies were sent out in December, but additional copies are still available. The five tapes are:

Radar School and CEDAR Prize Lecture:

1) Don Farley - Probing the Upper Atmosphere and Ionosphere with Large Radars
Ray Greenwald - Coherent Radar Studies of the Ionosphere

2) Erhan Kudeki - Middle Atmosphere Radar Techniques
Jim Vickrey - Sondrestrom
Tony Van Eyken - EISCAT
Mike Buonsanto - Millstone

3) Rich Behnke - Arecibo
Ron Woodman - Jicamarca
Sho Fukao - MU
Colin Hines - The Doppler Spreading Theory of Gravity Wave Spectra
(*1992 CEDAR Prize Lecture*)

Tutorials:

4) John Plane - Metallic Layers in the Mesosphere
Eric Jensen - Noctilucent Clouds: An Indicator of Global Change?
Judith Lean - Effects of Solar Variability on Global Change

5) Ray Roble - Overview of the Thermosphere/Ionosphere General Circulation Model (TIGCM)
Mike Lockwood - Time-Varying Convection

If you wish to get a copy of the tapes, please contact Dr. Barbara Emery at the address listed on the registration form.

Barbara Emery, NCAR

Correction

Please note that Dr. Miguel Larsen's phone number was incorrectly listed in the previous issue. The correct number is (803) 656-5309. I apologize for any inconvenience.

Laurie Shelton, Production Manager

Early Workshop Entries: CEDAR-93 Meeting

The following pertains to the Tentative 1993 Annual CEDAR Meeting Agenda listed on page 11. Some of the known workshops to date are: LTCS (Jeff Forbes), CAT (Maura Hagan), and PRIMO (Dave Anderson). These three workshops will be studying the LTCS-2 (5-10 Dec., 1988) and LTCS-6 (4-10 Dec., 1991) periods, but from different perspectives. Other planned workshops include: Accessing the CEDAR Data Base (Barbara Emery), Storm Studies (Mike Buonsanto), A First Look at the CADITS/MLTCS, 20-30 Jan., 1993 period (Mike Kelley), and Amigos de Arecibo (Mike Kelley/Craig Tepley).

Tentative 1993 Annual CEDAR Meeting Agenda
Sponsored by NSF, HAO/NCAR, U. of CO, and NIST

Monday, June 21, 1993 - NIST Auditorium

8:30 - 9:30 Introduction and Welcome
(NCAR, HAO, Kelley, students, post-docs)

9:30 - 10:15 Tutorial Lecture #1
J. Forbes - Tides and Global Oscillations

10:15 - 10:45 Break

10:45 - 11:00 Polar Cap Observatory - M. Kelley

11:00 - 11:15 Large Atmospheric Observatory - C. Gardner

11:15 - 11:30 Canadian Network for Space Research - L. Cogger

11:30 - 12:00 Project 1: Middle Atmosphere Study (30-100 km) - R. Lowe

12:00 - 2:00 Lunch

2:00 - 4:30 Workshops

4:30 - 6:30 Poster Session A at NCAR Mesa Lab

5:30 - 7:00 Reception at NCAR Mesa Lab

Tuesday, June 22, 1993

8:30 - 9:00 NSF/CEDAR Issues - Rich Behnke/Sunanda Basu/ Bob Robinson

9:00 - 9:45 Tutorial Lecture #2
R. Meier - UV Spectroscopy

9:45 - 10:15 Break

10:15 - 11:15 CEDAR 10th Anniversary
To be determined
Romick - Early Days
Thayer - From Student to CEDAR Awardee
Kelley - Present Days

11:15 - 12:15 Campaign Summaries
LTCS - Salah
GISMOS - de la Beaujardiere
GTMS ETS GTS GITCAD CADITS CAT - A Retrospective of Collaborative Thermospheric Studies - M. Hagan and others

12:15 - 2:00 Lunch

2:00 - 5:30 Workshops

Wednesday, June 23, 1993

8:30 - 9:00 CEDAR Prize Lecture

9:00 - 9:45 Tutorial Lecture #3
R. Walterschied - Gravity Waves

9:45 - 10:15 Break

10:15 - 12:15 Poster Session B at NIST

12:15 - 2:00 Lunch

2:00 - 5:30 Workshops

6:00 - 8:30 Barbecue at NCAR Mesa Lab

Thursday, June 24, 1993

8:30 - 9:15 Various Reports from CEDAR Post-Docs

9:15 - 10:00 Tutorial Lecture #4
G. Rostoker - Geomagnetic Substorms

10:00 - 10:30 Break

10:30 - 12:30 UARS Reports (30 minutes each)
Solar UV Variations - G. Rottman
PEM - D. Winningham
HRDI - P. Hays
WINDII - G. Shepherd

12:30 - 2:00 Lunch

2:00 - 5:30 Workshops

Friday, June 25, 1993

8:30 - 9:15 Various Reports (TIMED, FREJA, GEOTAIL)

9:15 - 10:00 Tutorial Lecture #5
D. Torr - The Photochemistry of the Lower Thermosphere and Mesosphere: What Has Been Achieved and What Remains to Be Done

10:00 - 10:30 Break

10:30 - 11:00 Various Reports

11:00 - 12:00 Poster Prize Awards, Future Plans for CEDAR, Concluding Remarks

12:00 - 2:00 Lunch

2:00 - 5:00 Workshops (as needed)

Saturday, June 26, 1993 - Data Analysis School in the NIST Auditorium

9:00 - 4:30 School on Data Analysis Techniques in the Geospace Sciences - J. Forbes (organizer)

SCHOOL ON TIME SERIES ANALYSIS

A One-Day Data Analysis School
Saturday, June 26, 1993
NIST Auditorium, Boulder, CO

Sponsored by the CEDAR Workshop
and In Conjunction with
The GEM Workshop (June 28-July 1, 1993)

Tutorial lectures will be given on analyses of data time series from a practitioner's point of view. Time limitations preclude an exhaustive treatment of this extensive subject; however, for those without formal training in digital signal processing who are (or plan to be) engaged in analyses of data time series (perhaps using commercially-available software packages), this course will provide insight into the power and pitfalls of several popular methodologies. A common geophysical data set will be analyzed by all speakers to illustrate various points. A tentative syllabus and list of speakers is given below; this is subject to some modification prior to June 26.

Time	Topic	Speaker
8:30	I. Introduction to the Fourier Transform -Fourier series -Continuous transform -Discrete transform -Autocorrelation functions and power spectra -Windowing	Prof. R. Clark U. New Hampshire
10:00	Break	
10:30	II. Error Analysis and Other Topics -Periodogram -Confidence and significance limits -Cross-correlation and cross-spectra	Prof. S. Avery U. Colorado
12:00	Lunch	
1:30	III. Filtering -Types of filters -Problems and pitfalls (ringing, phase distortion, etc.) -Complex demodulation -Sliding FFT	Prof. R. Vincent U. Adelaide
3:00	Break	
3:30	IV. Nonstationary Time Series -One or more of the following topics: Wavelets Multispectral analysis	Dr. F. Vial CNRS/LMD
5:00	Panel Discussion	
5:30	Adjourn	

Registration Fee: For CEDAR registrants, there is no extra fee; however, registration is required. All others, including GEM registrants, are required to pay a $20 registration fee to cover the costs of snacks and photocopying of lecture notes, etc. The registration fee is waived for students. Students still need to register, and should register before **May 31**, or will be liable for a late fee of $2. Late registrants (after May 31) for the Data School only will be charged $25.

Registration: Registration is required. To register, fill in the CEDAR Registration Form available in this issue of the CEDAR Post, and check off the parts pertaining to the Data Analysis School (2,4a-c). Checks should be made payable to NCAR, and forms and fees sent to: Dr. Barbara Emery, NCAR/HAO, P.O. Box 3000, Boulder, CO, 80303; emery@ncar.ucar.edu; tel. (303) 497-1596; fax (303) 497-1589.

Other Information: For other information on the School, contact Prof. Jeff Forbes, Coordinator, School on Time Series Analysis, NCAR/HAO, P.O. Box 3000, Boulder, CO, 80303, jforbes@ncar.ucar.edu; tel.(303) 497-1512; fax (303) 497-1589.

Registration Form
1993 Eighth Summer NSF CEDAR Workshop
June 21–26, 1993

National Institute of Standards and Technology – NIST
National Center for Atmospheric Research –NCAR

1. PLEASE PRINT

   Name: _____

   Institution: _____

   Address: _____

   _____

   Telephone: (_____)_____ FAX: (_____)_____

   E-mail: _____ Citizenship: _____

   Are you a: Student ( ) Tutorial Speaker ( )

NOTE: Students registering after **May 31** will be charged a $5.00 late fee. Students wanting travel funds should register before **April 15**.

2. I plan to attend the Data Analysis School on Saturday, June 26 _____.

3. I plan to present a poster at the meeting _____.
   NOTE: Send the title and author list to Dr. James Hecht by **May 31** in order to be considered. (For address, please see "Call for Poster Papers".) Also, please indicate whether the first author is a student. Students will be given preference if there are space limitations.

4. (a) Enclosed is my registration fee of $70.00 _____.
   (Fee includes reception and barbecue. Due **May 31** for $15.00 discount.)
   NOTE: 1) Foreign registrants can pay $70.00 on arrival provided this registration form is in by **May 31**.
   I will take this option _____.
   2) FEE WAIVED FOR STUDENTS AND TUTORIAL SPEAKERS.
   ($5.00 late fee charged for students registering after **May 31.)**

   (b) Enclosed is my late registration fee of $85.00 _____. (Due after **May 31.)**

   (c) Enclosed is my registration fee for the Data Analysis School **only** of $20 _____, $25 if after **May 31** _____.
   NOTE: FEE WAIVED FOR STUDENTS REGISTERING BEFORE **MAY 31**. Late fee of $2 ____ after **May 31**.

5. (a) I plan to attend the barbecue at NCAR on Wednesday, June 23 _____.

   (b) I am bringing _____ guest(s) to the barbecue at NCAR Wednesday, June 23, and enclose $15.00/guest (indicate amount enclosed) _____.

NOTE: If registration payment is not enclosed with this form, please be certain that checks sent separately identify you and the workshop. Checks for workshop (and guests for the barbecue) should be made payable to NCAR. Foreign registrants can pay on arrival provided they mail their registration forms in early. Please send correspondence to:

Barbara Emery
HAO/NCAR
P. O. Box 3000
Boulder, CO 80307-3000
(303) 497-1596
FAX Number: (303) 497-1589
Internet: emery@ncar.ucar.edu
SPAN: 9580::"emery@ncar.ucar.edu"

****STUDENTS** Please complete BOTH sides of this registration form.**

Application for Student Financial Support to Attend the Annual CEDAR Meeting

All students are eligible to receive a registration fee waiver, including those from non-US institutions. Travel funds and per diem funds are also available for students from US institutions. All students must fill out this application form. Application deadline is **April 15, 1993**. Professional Travel in Denver will make airline reservations for students travelling from cities where the government rate to Denver is cheaper than the early reservation, Saturday night stayover rate. At the moment, these cities are: Boston, Cincinnati, Dallas, Dayton, Detroit, Houston, Los Angeles, Pittsburgh, Salt Lake City, San Francisco, Spokane, and Tucson. If you are flying from one of these cities, contact Cindy in the Groups Department of Professional Travel at (800) 333-6338 or (303) 488-0570 to make airline reservations after **May 1**. Students travelling from other cities are responsible for getting their own tickets for a Saturday night stayover (either June 19 or 26) and will be reimbursed after the meeting. Students flying from Seattle can choose either way since the prices are equivalent.

PLEASE PRINT

Name: _____

University Address: _____

_____

_____

Phone: (____)_____ Fax: (____)_____ E-mail: (____)_____

Mailing Address (if different): _____

_____

_____

Expected Degree and Date of Graduation: _____

Advisor(s) and Phone Number: _____

Research Interests: _____

_____

_____

_____

Instruments, Models, or Data Used: _____

_____

_____

_____

Advisor's Signature of Student Status:

I confirm that the applicant is a ( ) graduate ( ) undergraduate student at my university or research laboratory and is working on a research project related to the CEDAR Program.

Research Advisor's Signature: _____

University of Colorado Summer Conference Housing Application
Main Campus

COMPLETE THE INFORMATION REQUESTED BELOW AND SEND TO THE ADDRESS INDICATED AT THE BOTTOM OF THE FORM.

Name of Conference: NSF CEDAR Meeting, Summer 1993

Participant's Name: _____ Sex: _____
(last) (first)

First Night's Lodging: _____ Last Night's Lodging: _____
(date) (date)

Address: _____ City: _____ State: _____ Zip: _____

Telephone: (Home) _____ (Business) _____

Please request one of the following:

*Single Room _____ Double Room _____ (Roommate Preference if Any) _____

Special Requests (Smoker/Nonsmoker, etc.) _____

*There are a limited number of single rooms. If a single room is unavailable, you will share a double room with another conference participant.

Complete if Accompanied by Spouse and/or Family:

Spouse's Name _____ First Night's Lodging _____ Last Night's Lodging_____

Child's Name _____ Age ____ Sex____ Dbl ____ Sngl ____ 1st Night____ Last Night_____

" Name _____ Age ____ Sex____ Dbl ____ Sngl ____ 1st Night____ Last Night_____

" Name_____ Age ____ Sex____ Dbl ____ Sngl ____ 1st Night____ Last Night_____

Will a rollaway bed be needed? _____ Crib? _____ **Total Number in Party** _____

PAYMENT IS DUE AT CHECK-IN. Cash, traveler's checks, personal checks, VISA and MasterCard will be accepted. DO NOT SEND MONEY IN ADVANCE. PHONE-IN REGISTRATIONS ARE NOT BEING ACCEPTED, BUT IN CASE OF ANY QUESTIONS OR EMERGENCIES, THE AREA MANAGER'S TELEPHONE NUMBER IS (303) 492-6885.

MAIL TO: Main Campus Conference Housing Area
142 Cheyenne-Arapaho Hall
Boulder, CO 80310

FAX 492-4646

Boulder Lodging and Local Transportation Information

1993 Eighth Summer CEDAR Workshop
June 21–26, 1993

The facilities listed below have blocked rooms for workshop participants between the nights of June 19-June 27, 1993. Reservations must be accompanied by a credit card charge number or a deposit for the first night's lodging; Visa, MasterCard, American Express, and Discover credit cards are accepted at most of the hotels. Cancellations must be made before 4:00 PM on the arrival day to avoid being charged for the first night's lodging. The blocks of rooms at special workshop rates are only being held until the dates indicated below and they may fill up early. MAKE ALL RESERVATIONS AS SOON AS POSSIBLE AND SPECIFICALLY MENTION THE CEDAR WORKSHOP HOSTED BY NCAR (if using a Travel Agent, have them identify you in the same manner). Participating hotels and rates for June 19-June 27, 1993, are:

Hotel	Single*	Double*	Deadline	No. of Rooms
Days Inn 5397 S. Boulder Road Boulder, CO 80303 (303) 499-4422; FAX: (303) 494-0269	$49	$54 (Up to 4 People)	May 19	50
Holiday Inn of Boulder 800 - 28th Street Boulder, CO 80303 (303) 443-3322 or 1-800-542-0304	$63	$63	May 19	25
Homewood Suites Hotel 4950 Baseline Road Boulder, CO 80303 (303) 499-9922 or 1-800-225-5466; FAX: (303) 499-6702	$72 for a Suite w/ Kitchen (will accommodate 3-4 people; 1 bed is a sofa sleeper)		May 1	15
Courtyard By Marriott 4710 Pearl East Circle Boulder, CO 80301 (303) 440-4700 or 1-800-321-2211; FAX: (303) 440-8975	$66	$66	June 4	20

RESERVE ROOMS BEFORE DEADLINES TO ASSURE LOWER RATES

All hotels have comfortable accommodations and all of them, except the Courtyard, can provide shuttle service to local meetings if requested by individuals *in advance* (based on availability). The Days Inn and Homewood Suites provide free continental breakfasts with lodging. Homewood Suites also has a free social hour Monday through Thursday. Checkout times are 12:00 noon. All hotels have swimming pools. We were unable to book blocks of rooms at the Broker Inn or the Clarion due to a solar convention, but some individual rooms may be available.

*Hotel rates do not include 9.5% sales tax.

University of Colorado Dormitory Rooms & Meals:

	Single	Double	No. of Rooms
Main Campus Conf. Housing Area 142 Cheyenne-Arapaho Hall Boulder, CO 80310 NOTE: FOR EMERGENCIES ONLY: (303) 492-6885 (Suzy Campbell or her secretary)	$130.87	$106.23 (per person)	50(S), 50(D)

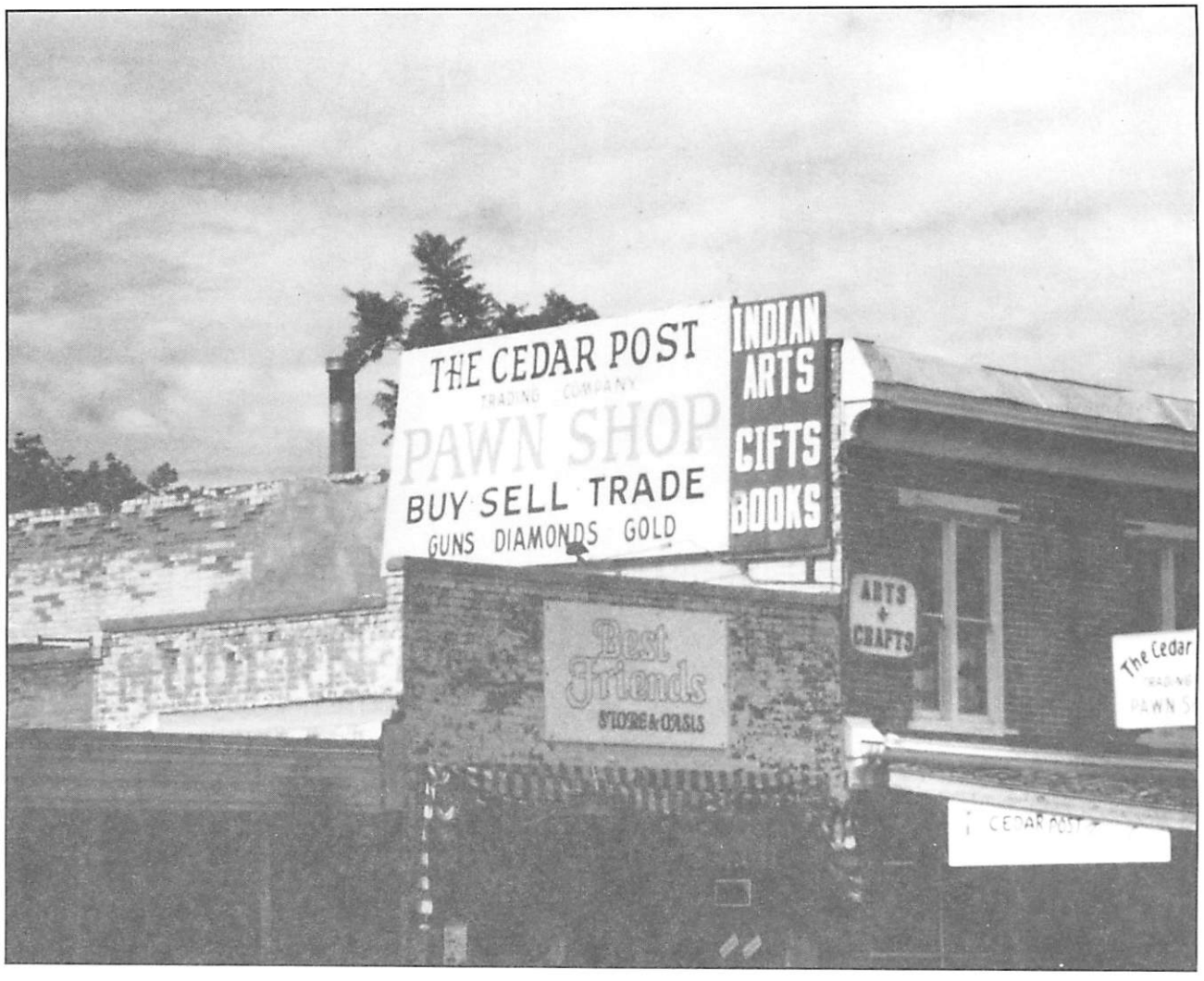
Rates for the campus package include a Dorm Room from 6/20 to 6/24 and breakfast every day from 6/21 to 6/25. Breakfast for $4.27, lunches at $5.34 and dinners for $6.41 are available to anyone on an a-la-carte basis. Early arrivals (6/19) and late departures (6/25-27) will pay an extra $21.90/night (single) or $16.97/night (double, per person). NO PHONE-IN RESERVATIONS ACCEPTED. PLEASE SEND THE REGISTRATION FORM PROVIDED HEREIN TO THE MAIN CAMPUS CONFERENCE HOUSING AREA. Also, have only ONE individual in charge of each group from each university. CU accepts VISA and MasterCard. The above prices include the 9.5% sales tax. Please check in at Hallett Hall. Parking permits for a week will be sold for $12.50 Monday morning.

GROUND TRANSPORTATION (Airport)

The Boulder Airporter Limousine Service (303/321-3222) and the Stapleton Supercoach (303/499-1951) will take reservations for direct transportation between the hotels, University and Denver's Stapleton Airport. Their schedules are staggered so you may find one more convenient for your arrival/departure.

DAY CARE

For child care while you attend the workshop, Children's World at 5377 Manhattan Circle in Boulder will accept children on a drop-in basis (based on availability). Children's World also offers summer field-trip programs. If you're interested, please call Karen Roux at (303) 494-3694. Many other daycare facilities are listed in the Boulder telephone directory under "Child Care."



NOTICE: Due to pressures on the FY93 NSF budget and the governmental emphasis on recycling, not to mention the prodigious and proliferate nature of the CEDAR Program, we have opened an outlet for used theories, grants, and equipment. All contributions accepted. Additional information and price lists available upon request. (Photo compliments of William Lotko, who reports that the idea is an NSF gem.)

The Cedar Post

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Address correction requested.

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