2002 REPORT FOR NSF UPPER ATMOSPHERE RESEARCH SECTION COMMITTEE OF VISITORS

Date of COV: July 10-12, 2002
Program: Upper Atmosphere Research Section
Division: Atmospheric Sciences Division
Directorate: Geosciences

Committee Membership:

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1.0 Process:

The Committee of Visitors (COV) for the Upper Atmosphere Research Section (UARS) of NSF's Atmospheric Sciences Division (ATM) met at NSF on July 10-12, 2002, to review the UARS program. The meeting began with a series of presentations by the cognizant NSF program officers. Dr. Richard Behnke, UARS Section Head, gave an overview of the COV process, discussed the NSF conflict of interest policy, and provided helpful summary statistics of the section's workload over the 3-year period covered by the review (FY 1999-2001). The individual program officers for the 4 programs within UARS then gave more specific presentations on their program's performance and results over the review period. These officers are: Sunanda Basu (Aeronomy Program, AER), Kile Baker (Magnetospheric Research Program, MAG), Thomas Bogdan (Solar-Terrestrial Research Program, STR), and Robert Robinson (Upper Atmosphere Facilities Program, UAF). It was pointed out that, during large portions of the period under review, both the STR and MAG programs were administered by program officers other than the incumbents. In addition, there was a lengthy period when the UARS section was understaffed and one program officer (Robinson) dealt with proposals from more than one program.

Following the summary presentations, which included information on program growth, Principal Investigator (PI) demographics, success rates, special program characteristics, and other topics, the COV then divided into subgroups and reviewed a large number of proposal jackets from all programs. The results of these jacket reviews were discussed by the committee as a whole in the presence of NSF staff before the development of the report itself.

The COV's report follows the recommended format for 2002. After summary statements pertaining to the section as a whole, each program is separately evaluated according to the two key questions concerning 1) the integrity and efficiency of the program processes and management, and 2) the quality of the results of NSF's investments in the form of outcomes and outputs which appear over time.

2.0 Overview of Findings:

2.1. Efficiency and Integrity of Processes

The UARS COV considers the section to be well managed and efficient, and the quality of the program directors uniformly high. The leadership of the UARS section is strong and effective. Important community-wide scientific research programs have been wisely designed, nurtured, and sustained over time, leading to an unprecedented level of community cooperation and coordination and, as a consequence, world leadership in upper atmospheric research. A reasonable balance among facilities, experimental and theoretical work is maintained. Each program has been carefully administered by dedicated program officers. There is evidence in each set of jackets that the relevant program officer has developed and documented a clear rationale for the funding decisions. The committee found very few cases where the decision might have been questionable. No skewing of the proposal evaluation procedures or process was evident.

Due consideration was given to issues of programmatic balance, career development for new investigators, and diversity. In many cases, the program officers have proactively communicated with reviewers, PI's, individuals representing other NSF programs and even other agencies to optimize the return on the NSF investment. The COV was particularly happy to see that program officers regularly counseled the PI's of declined proposals in constructive ways to help with future submissions. Figure 2.1.1 shows the growth of UARS programs over the past 8 years.

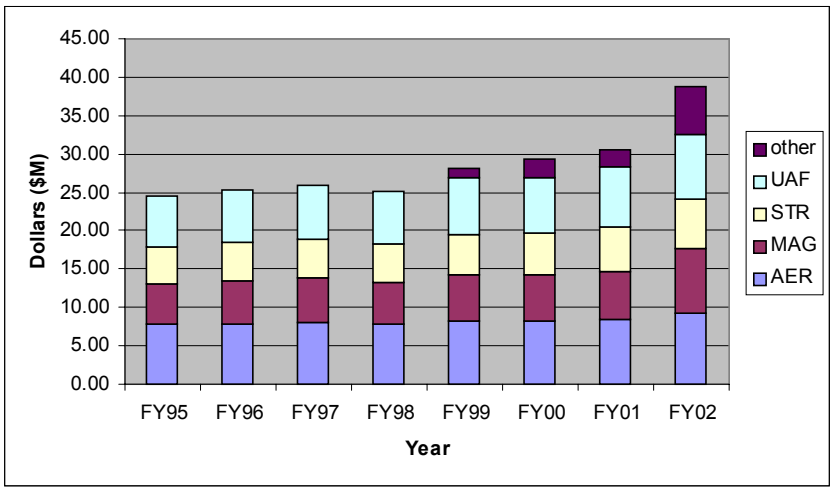


Figure. 2.1.1. Growth of UARS programs

2.2. Outputs and Outcomes

A hallmark of the operation of UARS has been the development of several influential community-wide initiatives, including the Geospace Environmental Modeling Program (GEM), the Coupling, Energetics, and Dynamics of Atmospheric Regions Program (CEDAR), the Solar, Heliospheric and Interplanetary Environment Program (SHINE), and the National Space Weather Program (NSWP). These programs were developed under UARS leadership and they have all served the community extremely well. It is hard to overstate the importance of these programs. CEDAR, for example, has created a community within Aeronomy where collaborations, small group interactions, and coordinated campaigns are now the norm, significantly extending and leveraging NSF investments. The science has flourished as a result. The annual CEDAR meeting in Boulder has become the intellectual hub for the community and a significant event for the mentoring of future geoscientists (approximately 100 students attend this meeting).

The CEDAR program has partnered with the NASA Thermosphere-Ionosphere-Mesosphere Energetics and Dynamics (TIMED) program to create a joint initiative to optimize the combination of space and ground-based observations of the upper atmosphere.

GEM has become the premier annual forum for interaction among magnetospheric scientists. The GEM meeting attracts space physicists from around the world.

SHINE is a growing initiative, providing a fundamental knowledge base for space weather. It integrates cosmic ray, heliosphere and the solar communities into a cohesive consortium. Figure 2.2.1 shows the growth in participation in the CEDAR, GEM, and SHINE programs.

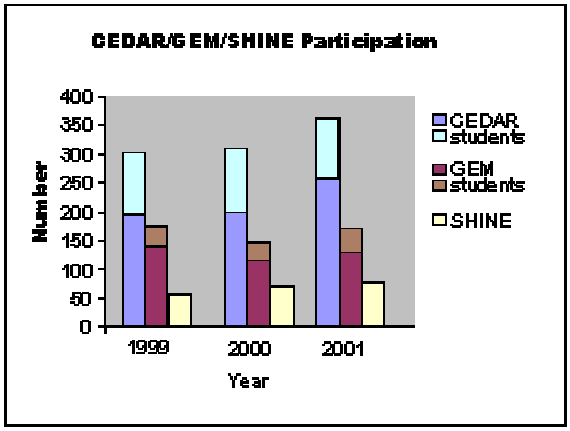


Figure 2.2.1. Healthy participation by students and researchers in the CEDAR, GEM, and SHINE annual workshops. The reduction in the GEM participation in 2000 was due to a simultaneous international meeting. Student participation in SHINE has not been documented.

The NSWP, developed initially by UARS, has strongly influenced the plans of several other agencies and now includes, for example, the very large NASA "Living with a Star" program. Figure 2.2.2 shows the recent explosive growth in the number of published papers with a space weather theme, a trend considered by the COV to be in direct response to UARS leadership of this emerging area.

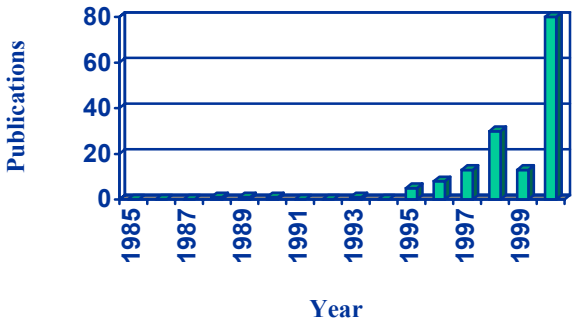


Figure 2.2.2. Growth in numbers of published papers with Space Weather theme

The new Advanced Modular Incoherent Scatter Radar (AMISR) project is one of the highlights of the leadership provided by the UARS Section Head. Following the withdrawal of the original Polar Cap Observatory (PCO) proposal in 2000, the Section rebounded with AMISR, a project that has the potential to revolutionize the understanding of atmosphere-ionosphere interactions, particularly at high magnetic latitudes. These and other developments supported by UARS staff have led to the current happy situation where upper atmospheric research is a truly vibrant field of research.

2.3. Concerns and Issues

In reviewing the jackets, COV members found evidence of stress associated with a high and increasing workload for the program managers. During the period covered by the review, there were several instances of prolonged staffing vacancies and these periods led to unfortunate increases in the processing time for proposals. Figure 2.3.1 illustrates this point. In addition, there was some concern expressed about the level of reviewer response (that is, the percentage of reviewers submitting a responsive review in a timely manner), particularly in the STR program. The detailed report below provides more information pertinent to this concern and makes some recommendations to alleviate the situation. Although the specific vacancies that led to the increases in processing time have now been filled, in the opinion of the COV, UARS remains chronically understaffed and the COV is concerned for the future, should expected growth in NSF's core programs occur.

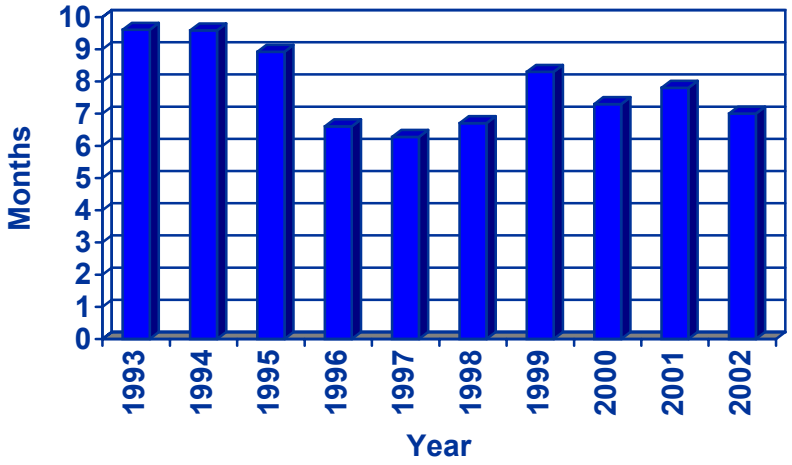


Figure 2.3.1. Processing time for UARS proposals from 1993-2002. Note the increase in 1999-2001, ascribed by the COV to understaffing at UARS. The vacancies at UARS were filled by 2002.

Another concern expressed by members of the COV involved the level of support and activity relating to education and outreach within the UARS programs. Although there are good examples of important individual efforts in this regard, the overall portfolio left the COV with the impression that educational efforts are more of a "byproduct" than an indispensable, highly-valued, core component of the program. The COV urges NSF to find ways to facilitate more profound and mutually beneficial interactions between

GEO/UARS and the Education and Human Resources (EHR) programs. One related aspect of this concern centers on the COV's perception that the number of tenured faculty training the next generation of researchers is insufficient to maintain the needed momentum in the field. The COV applauds UARS creative (though preliminary) plans to find ways to augment the number of tenured professors with strong interests in space physics.

In some instances, the COV found that the jackets were hard to work with. Some specific proposals were difficult to locate and the storage of proposals according to date of "closure" (i.e., after final closeout and receipt of final report) made it difficult to select appropriate jackets for review – particularly for accepted proposals that had no-cost extensions or supplementary funding. The COV recommends rapid transition to a full electronic process for program documentation review, with a user-friendly search capability.

In general, the COV found that the response of both proposals and reviewers to the need to document "broader impacts" of the proposed research was mixed. Much of the commentary in these sections was not particularly useful. The COV recommends that NSF provide explicit guidance to reviewers to help them with this component of the review at the time of the first contact (the COV found that very few reviewers demonstrated evidence of having visited the relevant NSF-wide web site).

The COV had difficulties understanding and interpreting the "high-risk" and "cross-disciplinary" categories that were introduced in the template provided to the Panel. It appeared that the Program Directors had similar difficulties. One Program Director appeared to classify as "high risk" those proposals that received very mixed reviews, for which a difficult decision was then required of him/her. This approach runs the risk that one person's "high risk science" was another's "bad science." If the NSF wants this kind of information, we recommend that the Program Directors discuss within the UARS how to classify "high-risk" and "cross-disciplinary" categories internally, and then identify all funded proposals in these special categories in a more systematic manner. We do not recommend that reviewers be asked to categorize proposals into any of these special categories since such categorization might affect bias ratings.

A last cross cutting issue expressed by COV members relates to the difficulty of connecting UARS programs into NSF cross-directorate initiatives. NSF-wide initiatives, as currently constituted, are not well designed for UARS participation. Until that changes, UARS will be disenfranchised from such broad initiatives. This underscores the need for future budgetary growth in the UARS core or "base" program so that the section receives its fair share of NSF funds. The COV recommends that UARS staff participate and be consulted in the development of future NSF-wide initiatives. NSF leadership should consider ways to provide UARS viable access to cross-directorate and cross-agency initiatives.

The following materials provide more detailed information on the COV findings. Part 3 provides information on the integrity and efficiency of the individual UARS programs.

Part 4 provides information on the outputs and outcomes for the Section as a whole and lists specific highlights from all of the individual programs.

3.0 Integrity and Efficiency of the Individual Program's Processes and Management

In general, the COV found that all programs within UARS were well managed, responsive to the respective scientific communities and efficiently run in accordance with NSF goals and objectives. The COV elected to use the template provided by NSF to summarize comments germane to the individual sections in the following order: AER, UAF, MAG, STR.

3.1 Aeronomy Program:

The COV found the review process and management of the Aeronomy Program to be outstanding. The committee identified no significant problem areas. In particular, we wish to complement the program director (Sunanda Basu) for her outstanding leadership, for the truly excellent quality of the Aeronomy program, and for her conscientious and tremendously supportive interactions with the scientific community. The dialog she initiates with proposers was especially helpful in resolving discrepancies or misunderstandings on the part of reviewers. We found only a very small number of awards or declines that did not appear to be consistent with the documented reviewer ratings. The reasons for these decisions were readily understood through dialog with the program director.

The COV identified several relatively minor areas where the approach followed by the AER program director could be changed to help future COV's obtain an even better overview of the process. These are listed below, either in the tables or in the section of recommendations.

3.1.1 Questions about the quality and effectiveness of the AER program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, or DATA NOT AVAILABLE
Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) **Comments:** We find that the change in the panel review to include a lead and secondary reviewer (scribe) for each proposal helps to minimize biases in the process.	Yes

Is the review process efficient and effective? **Comments:** We found it difficult from the overall summaries in Tab 12 to determine the true number of "no return" reviews, because panel "no-reviews" were included in the total. We recommend a column that accurately reflects the true number.	Yes
Is the time to decision appropriate? **Comments:** Of course, delays can occur as the result of slow response on the part of reviewers. This does not appear to be a serious problem in the Aeronomy Program. Any additional delays incurred by follow-up dialog with proposers are entirely appropriate and very important in arriving at the final decision.	Yes
Is the documentation for recommendations complete? **Comments:** We found the documentation to be very detailed and complete. We found no anomalies in the jackets we reviewed.	Yes
Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines? **Comments:** We assume this refers to reviewers, not program director reviews. The reviewers usually discussed the "intellectual merit" in great detail, but the "broad impact" was often either ignored or misunderstood. We recommend that better guidelines be provided to the reviewers, that the requirement for meaningful input be emphasized to the reviewers. Having said that, we recognize that the program director is sufficiently knowledgeable to judge the importance of broad impact for an individual proposal.	Yes

3.1.2. Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by AER reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	% REVIEWS
What percentage of *reviews* address the <u>intellectual merit</u> criterion?	100
What percentage of *reviews* address the <u>broader impacts</u> criterion? However, the COV found that few provided meaningful information.	70
What percentage of *review analyses* (Form 7's) comment on aspects of the <u>intellectual merit</u> criterion?	100
What percentage of *review analyses* (Form 7's) comment on aspects of the <u>broader impacts</u> criterion?	100

Discuss any concerns the COV has identified with respect to NSF's merit review system.

See fifth question under 3.1.1

3.1.3. Questions concerning the selection of AER reviewers.

SELECTION OF REVIEWERS	YES , NO Or DATA NOT AVAILABLE
Did the program make use of an adequate number of reviewers for a balanced review? **Comments:** We endorse the expanded review process, including the addition of a scribe.	Yes
Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:**	Yes
Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? **Comments:**	Yes
Did the program recognize and resolve conflicts of interest when appropriate? **Comments:** See introduction and the 3rd question in 3.1.1	Yes
Did the program provide adequate documentation to justify actions taken? **Comments:** We found that the summary discussions were very complete and helpful to use in evaluating the decision making process.	Yes

Discuss any concerns identified that are relevant to selection of reviewers in the space below.

There were no concerns.

3.1.4 Questions concerning the resulting portfolio of AER awards under review**.**

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
Overall quality of the research and/or education projects supported by the program. **Comments:** The quality of research is consistently of the highest caliber.	Appropriate
Are awards appropriate in size and duration for the scope of the projects? **Comments:** We support the move at NSF to increase the funding duration (perhaps up to five years.) This is often a much more meaningful period to complete a research activity, and is better matched to thesis research.	Appropriate
Does the program portfolio have an appropriate balance of • **High Risk Proposals** The number of proposals identified as high risk is relatively small. Because the NSF is one of the few agencies that supports basic research, perhaps a larger number of high-risk/high-payoff proposals would be acceptable, especially from promising young researchers.	See Comment
• **Multidisciplinary Proposals** There appears to be sufficient balance of multidisciplinary proposals within the Aeronomy Program . The number of cross-disciplinary proposals is relatively small.	Appropriate
• **Innovative Proposals** One could say that most or all of the proposals are for innovative research. Those without "anything new" were soundly trounced by the reviewers.	Appropriate
Of those awards reviewed by the committee, what percentage of projects address the integration of research and education? Because most of the grants go to universities, invariably, support of graduate student research is at least implicitly covered by the grant. Using this definition, most of the proposals integrate research and education.	**Percentage** Very High

Discuss any concerns identified that are relevant to the quality of the projects or the balance of the portfolio in the space below.

The COV had no concerns with regard to quality and balance of the AER Program (see, however, comments in Table).

3.2. Upper Atmospheric Facilities Program

Overall, our opinion is that the Upper Atmospheric Facilities (UAF) Program Director, Bob Robinson, has done an exceptional job of managing the programs that he oversees. He consistently exhibits outstanding programmatic instincts and superb leadership.

One overarching issue that we saw in many of the facility reports were comments addressing aging infrastructure, fragile and hard-to-replace klystrons, etc. Robust infrastructure is critical to the current and future operations of these sites, and for the future of science in this country as a whole. We believe that NSF equipment and instrumentation funding should be made available to discipline officers to ameliorate this problem. In the age of microelectronics and nanotechnology, NSF should be a leader in stimulating the development of next-generation equipment.

The COV identified several relatively minor areas where the approach followed by the UAF could be changed to help future COV's obtain an even better overview of the process. These are listed below, either in the tables or at the end of 3.2.

3.2.1 Questions about the quality and effectiveness of the UAF program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, or DATA NOT AVAILABLE
Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) Comments:	Yes
Is the review process efficient and effective? Comments:	Yes
Is the time to decision appropriate? Comments:	Yes
Is the documentation for recommendations complete? Comments: We found the documentation to be very detailed and complete. We found no anomalies in the jackets we reviewed.	Yes
Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines? Comments:	Yes

Discuss issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures:

With respect to the quality and effectiveness of merit review procedures, we find that the review process in the UAF program is efficient, effective, and timely. The reviews are consistent with the priorities and criteria stated in the program's solicitations, announcements, and guidelines. It was evident that reviewer responsiveness was high for this program. However, we did find that the program officer's comments concerning funding recommendations did not consistently include all relevant details. Nevertheless, we understood the rationale for decisions we questioned after having direct discussion with the program officer. We are satisfied that all decisions were appropriate.

With respect to the review mechanism in place, we have a number of comments. The UAF program oversees both individual PI grants and major facilities. The process to review the individual PI proposals is balanced and thorough, and we saw no systematic biases of any type. We did note that the panel process would occasionally override mail-in reviewers in a way that seemed arbitrary. However, we also note that the program officer has the freedom to apply his own judgment in these cases, and we recognize that no process is perfect. We are satisfied that this process is as fair as possible at present.

Reviews of the major facilities would be significantly enhanced by routine site visits, which we recommend on a triennial basis, given the five year renewal schedule for these proposals. The last such site review in 1996 proved invaluable to us as reviewers and to the leadership of each facility. Concerns addressed in the 1996 review were incorporated in the renewal proposals and deficiencies were corrected at the appropriate facilities. In addition, we think that the sites should track all publications involving outside users of facility data and/or resources, and include this information in their renewal proposals. This information would establish a track record of scientific productivity and community utility.

Highlights of the leadership of the UAF program officer include the modifications to the Arecibo cooperative research agreement. Changes at Arecibo include a new "specific statement of work" and the creation of an Assistant Director position for atmospheric sciences, correcting the two main concerns of the 1996 review.

3.2.2. Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by UAF reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	**% REVIEWS**
What percentage of *reviews* address the <u>intellectual merit</u> criterion?	100
What percentage of *reviews* address the <u>broader impacts</u> criterion?	>70

What percentage of *review analyses* (Form 7's) comment on aspects of the <u>intellectual merit</u> criterion?	100
What percentage of *review analyses* (Form 7's) comment on aspects of the <u>broader impacts</u> criterion?	>70

Discuss any concerns the COV has identified with respect to NSF's merit review system.

The majority (above 70%) of reviews and the review analyses addressed the criteria of "intellectual merit" and "broader impacts." The only comment we have concerning the merit review system is the lack of clarity of the grading process within a given competition. Summaries should include raw numerical scores, the grading scale used, and comparative statistics for the overall competition under review by the COV.

3.2.3. Questions concerning the selection of UAF reviewers.

SELECTION OF REVIEWERS	YES , NO Or DATA NOT AVAILABLE
Did the program make use of an adequate number of reviewers for a balanced review? **Comments:** see below	Yes
Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:** see below	Yes
Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? **Comments:** see below	Yes
Did the program recognize and resolve conflicts of interest when appropriate? **Comments:** see below	Yes
Did the program provide adequate documentation to justify actions taken? **Comments:** see below	Yes

Discuss any concerns identified that are relevant to selection of reviewers in the space below.

We have no concerns about the selection of reviewers. An adequate number of reviewers with the appropriate expertise was always utilized. The reviewers selected reflected a balance of geography and type of institution. To the extent that underrepresentation of women/minority groups was a problem, we feel that this was not the fault of the UAF program officer, but rather a situation endemic to the scientific population as a whole. The program officer did recognize conflicts of interest, and appeared to have resolved all of them. Documentation was adequate to justify all actions taken.

3.2.4 Questions concerning the resulting portfolio of UAF awards under review**.**

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
Overall quality of the research and/or education projects supported by the program. **Comments:** see below	Appropriate
Are awards appropriate in size and duration for the scope of the projects? **Comments:** see below	Appropriate
Does the program portfolio have an appropriate balance of • **High Risk Proposals** **Comments:** see below	See Comment
• **Multidisciplinary Proposals** **Comments:** see below	Appropriate
• **Innovative Proposals** **Comments:** see below	Appropriate
Of those awards reviewed by the committee, what percentage of projects address the integration of research and education? **Comments:** see below	**Percentage** Very High

Discuss any concerns identified that are relevant to the quality of the projects or the balance of the portfolio in the space below.

The overall quality of research and education projects that we saw was outstanding. However, we believe that Education and Human Resources (EHR) interactions with UAF should be strengthened. It appears that EHR may not have exploited the rich possibilities open to them within the outstanding UAF portfolio. UAF facilities are exceptional tools for motivating future scientists and engineers and for articulating the mission and goals of science for the benefit of the general public.

The projects covered within the UAF program varied from small one year grants to five year, multi-million dollar cooperative agreements with major facilities. All of the UAF major facilities addressed the integration of research and education. Roughly 30% of the individual grants addressed this issue. The majority of the proposals were multidisciplinary and contained innovative science. In certain cases, the program director appeared to take justifiable risks.

The UAF portfolio provides a unique opportunity to unify all the elements of the Upper Atmospheric Research Section. In this regard, we are happy with the programs at this point, but anticipate that the portfolio will be increasingly leveraged in the future.

3.3 Magnetospheric Physics Program

The magnetospheric subpanel used a two-step procedure for reviewing proposal jackets. The first step considered rejected proposals with high ratings (very good or better) and accepted proposals with low ratings (good or worse). This step provided data to evaluate the process by which the program director made decisions that clearly went against reviewer recommendations. The question is, were these decisions defensible or not? The second step considered samples of accepted and rejected proposals chosen at random. These provided data on which to base generalities, to discover anomalies, and to build statistics. The following comments summarize our findings.

<u>Plaudits</u>

- The COV finds that UARS's magnetospheric program director (Kile Baker) and the interim director (Bob Robinson) did an outstanding job of managing NSF resources in this area.
- The review process appears to be bias free and as fair as any system that requires human decisions.
- The emphasis in the above statement is on "managing," as comments below in response to mandated questions will demonstrate.
- Among aspects that characterize effective management, leadership by the directors is especially pronounced and commendable. Evidence of leadership takes several forms: a policy of actively mediating between reviewers and PIs to ensure that reviewer concerns have been adequately addressed before accepting a proposal; a rule of negotiating with the PI to arrive at a budget (often reduced from that requested) that optimizes the use of the program manager's funds for the science return of the project proposed; a skill in recognizing where it might be possible to leverage program funds for a project with other intra or inter-agency funds and taking the initiative to seek such funds; a pattern of fostering junior

scientists, even if rejected, to resubmit an improved proposal; and a policy of minimizing the shock of rejections in serious cases with a period of sustaining level funding.
- The program director demonstrated willingness to advocate for funding in cross disciplinary and targeted programs such as POWRE, ITR and Math-Geosciences collaboration.
- We are confident in the program director's judgment in programmatic and science funding decisions.

Issues

- The program director position for magnetosphere was unfilled for one third of the interval covered by the COV. While the acting director, Robert Robinson, did a commendable job, the effects of this personnel shortage was evident in longer intervals associated with the submission-review-award process. This situation has been rectified for the moment, but could present itself again within other UARS programs .

3.3.1 Questions about the quality and effectiveness of the MAG program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, or DATA NOT AVAILABLE
Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) **Comments:** Panels are convened for program solicitations (GEM, Space Weather), *Ad hoc* reviews are universal and present in all jackets. All jackets had minimum of three *Ad hoc* reviews when panels were convened and a minimum of four solicited reviews otherwise. There is strong evidence of interactive communication between program director and PIs.	Yes
Is the review process efficient and effective? **Comments**: The review process allowed the program director to reach reasoned, understandable, and well documented decisions.	Yes
Is the time to decision appropriate? **Comments:** Six months is the target dwell time. The average dwell time for the jackets we reviewed exceeded six months. We associate this extended dwell time with understaffing during personnel transition. This situation appears to have been alleviated by the permanent hire of a program director for MAG.	No
Is the documentation for recommendations complete? **Comments:** Yes. All jackets we reviewed appeared to have complete records of activity and process.	Yes

Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines? **Comments:** Yes, reviewers are responsive to criteria stated in program solicitations. Most offered thoughtful comment and criticism useful to the program director and panel review process.	Yes

Discuss issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures:
The program director (Kile Baker) is proactive in soliciting and critiquing reviewer input and improving panel processes. He has implemented a "Highly Recommend/ Recommend/ Not Recommend" rating for panel reviews that allows a clear distinction in proposal quality. We wish to emphasize that the review process is strongly and positively influenced by direct and active communication between the program director, the reviewers and the PI's. This communication process allows the program director to be satisfied that PI's have responded adequately to reviewer concerns.

3.3.2 Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by MAG reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	% REVIEWS
What percentage of *reviews* address the intellectual merit criterion?	95%
What percentage of *reviews* address the broader impacts criterion?	67%
What percentage of *review analyses* (Form 7's) comment on aspects of the intellectual merit criterion?	100%
What percentage of *review analyses* (Form 7's) comment on aspects of the broader impacts criterion?	77%

Discuss any concerns the COV has identified with respect to NSF's merit review system.

We note that the reviewer form elicits reviewer response that the template specifies. When the program director specified response categories for " intellectual merit" and "broader impacts," reviewer responses included both criteria. Reviewers give fuller, more insightful responses to the 'intellectual merit' criterion than the 'broader impacts' criterion. The latter criterion needs more emphasis if it is to be a useful discriminator in award decisions.

3.3.3 Questions concerning the selection of MAG reviewers.

SELECTION OF REVIEWERS	YES , NO Or DATA NOT AVAILABLE
Did the program make use of an adequate number of reviewers for a balanced review? **Comments:** The program director typically solicits 6 ad hoc reviews and typically receives four (sometimes five) returned reviews.	Yes
Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:** Proposals were consistently targeted to knowledgeable reviewers. In our sample, over 50% worked in the same problem area.	Yes
Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? **Comments:** There were no obvious biases toward or away from population types. More than 50% of the sampled jackets had one or more female reviewers.	Yes
Did the program recognize and resolve conflicts of interest when appropriate? **Comments**: There were no cases where conflict of interest resolution became an issue. We take this to mean that potential COI problems were caught before they became problems.	Yes
Did the program provide adequate documentation to justify actions taken? **Comments:** In every case the program director's decision was justified by fully explicit reasoning based on documentation in the jacket. In some marginal cases the director made judgment calls that others might have made differently, but in each case the reasoning was clear and understandable.	Yes

Discuss any concerns identified that are relevant to selection of reviewers in the space below.

A two-out-of three return rate for mail reviews is not bad, but a higher rate would be better. We suggest that the program director emphasize in his agency talks to the magnetospheric community (e.g., at GEM workshops) the importance of reviewing when asked. The more reviews returned, the less likely it is that a decision will be based on the fluctuations of small numbers or the accidents of personalities. The program director has expressed a desire to have fewer panel reviews. We find this commendable, but it will require higher mail-in reviewer participation.

3.3.4 Questions concerning the resulting portfolio of MAG awards under review**.**

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
Overall quality of the research and/or education projects supported by the program. **Comments:** On average, "very good" divides accepted from rejected proposals.	High
Are awards appropriate in size and duration for the scope of the projects? **Comments:** The program director negotiated with the PIs to tailor the proposed project to the MAG program's budget and the project's scope. The program director was creative in frequently supplementing MAG funds with inter and intra-agency funds.	Yes
Does the program portfolio have an appropriate balance of • **High Risk Proposals** **Comments:** The program director identified three funded high risk proposals to the COV. Relevant data on declined high risk proposals were not available	Yes
• **Multidisciplinary Proposals** **Comments:** The program director has spearheaded an effort to fund efforts in ionosphere-magnetosphere coupling. One of the high risk proposals mentioned above clearly married new computational methods with magnetohydrodynamic code optimization. Many of the funded proposals clearly involve ingenious computational schemes which may not be readily identified as "multidisciplinary" since this kind of effort is viewed as routine in the space physics community.	DNA
• **Innovative Proposals** **Comments:** The proposal pressure from the community generates more innovative proposals than can reasonably be funded. The review process and the panel process combine to insure that the most innovative proposals rise to the top**.** It appears that the portfolio is well populated with innovative proposals, but there is no special designation or indicator to provide a quantitative answer to this question.	DNA
Of those awards reviewed by the committee, what percentage of projects address the integration of research and education? **Comments:** More than 50% of the jackets address graduate and post graduate education.	Criteria unclear

Discuss any concerns identified that are relevant to the quality of the projects or the balance of the portfolio in the space below.

Although pre-graduate education is a stated NFS priority, at present it is merely a by-product of funded proposals in the mag program, and not a direct goal. It would probably be possible to find an approach that more deliberately and optimally used program resources to enhance pre-graduate education. The thought is that if one regathered and consolidated the resources now used to support many tag-on efforts to satisfy the Foundation's interest in this area, one could design a larger, unified and more effective program. One could even focus the program on minority-serving institutions. Consider as an example the following model. Solicit proposals directed at producing Ph.D.s in magnetospheric physics (and other UARS disciplines) but with a special focus on training in pre-graduate education. Aim the program at students that have an interest in teaching at minority-serving institutions. To insure as far as possible the success of the program, provide students that complete the program satisfactorily with a "dowry" (e.g., setup funds and summer salary and research funds for a minimum of five years). This step would greatly enhance their employability by minority-serving institutions and it would be a strong incentive to attract students into the program.

3.4. Solar Terrestrial Research Program

After reviewing numerous “jackets,” the panel arrived at a number of conclusions, which are addressed in greater detail in the boxes below. Here, we provide a synopsis of our basic conclusions regarding the integrity and efficiency of the processes involved in the proposal review.

<u>Plaudits</u>

- The Panel was extremely impressed with the quality of the work, judgment, skills, and fairness exhibited by the three Program Directors (Schatten/Evenson/Robinson) involved in the STR Division over the period of review. It is a credit to NSF that people of this caliber are engaged in the administration and support of science at a national level. The Panel was also impressed with the ideas and energy of the new program director, Thomas Bogdan, and believes that the program is in very good hands.
- An overriding impression gained by the Panel was that the Program Directors were concerned first and foremost in supporting science, to the extent that they tried to find funding to support all highly regarded proposals at some level financially. Of particular credit, and reflecting the clear desire to strengthen and encourage the scientific mission of NSF, were the frequent efforts made by the Program Directors to work with potential PI’s who submitted promising but less highly rated proposals so that future proposal submissions could be improved. This both encouraged new or entering PIs, under-represented groups, and led to an improvement in the science supported by STR. One result of such encouragement by the Program Directors is a higher than average level within

Geosciences of new PI's and women within the UARS. This contributes immensely to the vitality of the field – it brings new and young scientists with fresh exciting ideas into the field; it provides them with opportunities to blossom and grow, and it ensures that older, more established scientists remain vigorous, competitive, and at the "cutting edge."

- The rotation of the Program Directors too had the salutary effect of bringing fresh ideas, vitality, new contacts and areas of expertise to the NSF.
- As a direct consequence of the above two bullets, the NSF, through its Program Directors, has had considerable success in building the STR community and moreover responding to grass-roots movements and new directions in a remarkably nimble and pro-active fashion. Examples such as SHINE and the Space Weather program illustrate both the leadership role that NSF has played and its response and accessibility to the STR scientific community it serves.
- The Program Directors have recognized too that the support of some proposals has the important and vital ramification of helping in the development of new academic programs within universities. This is a critical component of the educational arm of the NSF and one that promotes the active STR program to graduates, undergraduates, and post-docs.
- Overall, the Program Directors were found to have exhibited excellent programmatic and scientific judgment in selecting proposals for support and supporting these decisions with very clearly expressed reasoning. In general, the decisions to support high-risk programs and to support bold programs of research were well made.
- Finally, the program made good use of multiple avenues and different NSF programs to augment, where possible, funding of proposals. This also ensured an increased diversity in the nature of the proposals supported by the program.
- The discretion exercised by the Program Directors has been an important and positive aspect in maintaining the vitality of the STR program.

<u>Issues</u>

- The Panel was concerned at the low reviewer response rate (although we are told the STR return rate is still higher than that of most divisions). This resulted occasionally in an insufficient number of expert reviewers being available to guide the judgment of the Program Directors.
- While the Panel applauds the rotator system under which STR operates (see comments above), it presents certain logistical difficulties to the efficient and smooth running of the Division. In particular, the period under review was subject to several multi-month vacancies and nearly 8 months (FY01) of a Program Director working 1 day/week.
- The combination of the above two points resulted in some proposals being evaluated more slowly than the nominal 6 month review period that is regarded as reasonable. This should not be construed as a criticism of the rotator system for Program Directors but rather that the change-over should be managed better, possibly by initiating the search and appointment process earlier.
- An incoming rotator is faced with a start-up/learning period, which can also slow the turn-around time for proposals. This did not seem to be a great problem within

STR, but it may be helpful for future appointments to plan for such a start-up period.

- It appeared that the STR proposals were not well represented in the NSF cross-disciplinary programs such as ITR and MRI

3.4.1 Questions about the quality and effectiveness of the STR program's use of merit review procedures.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCEDURES	YES, NO, or DATA NOT AVAILABLE
Is the review mechanism appropriate? (panels, ad hoc reviews, site visits) **Comments**: The review process is largely "classical," following a format that has evolved over many years in agencies such as NSF and NASA. To the extent that it has been refined over the years, the review mechanism has worked many of the problems out of the system and , while admittedly imperfect and subject to the vagaries of human nature, personalities, and mistakes, is probably as fair and reasonable as we can expect. The imperfections in the system appear to average themselves out. The Panel notes that the write-in system works well provided a reasonable number of reviewers responds but can experience problems with small statistics if not. Sometimes panels are better logistically when evaluating program solicitations, but these can occasionally lead to the evaluation of a submitted proposal being dominated by a single personality on the panel – however, we found that the Program Director frequently used his discretion in resolving potential issues that could arise in these situations. Thus, the review process appears to work well, fairly, and is reasonably timely, and we believe that the discretion given to the Program Directors is essential to the successful operation of the process. We make some suggestions below that the NSF may wish to consider regarding some modifications to the review process which may help address concerns regarding the lower than desirable return rate by reviewers.	Yes
Is the review process efficient and effective? **Comments:** As discussed above, the Panel believes that the review process is both effective and as efficient as an imperfect but reasonably fair system can be. The efficiency and effectiveness of the system relies on the energetic efforts of the Program Directors and on the steadiness of the NSF staffing. Those proposals that were handled less expeditiously tended to occur when a Program Director was either new to the system or when working part-time.	Yes
Is the time to decision appropriate? **Comments:** See above.	No (during staff vacancy)

Is the documentation for recommendations complete? **Comments:** The documentation for the recommendations made by the Program Directors was exemplary.	Yes
Are reviews consistent with priorities and criteria stated in the program's solicitations, announcements, and guidelines? **Comments:** The Panel found that this was true almost uniformly.	Yes

Discuss issues identified by the COV concerning the quality and effectiveness of the program's use of merit review procedures:

As discussed in the first entry in the Table above, the Panel suggests that one reason for the somewhat low return-rate of referee reports by referees may be that the community is over-burdened by the pressure to write proposals constantly and to provide service in the form of refereeing proposals, papers, numerous committee activities, and so forth. There are many factors for the increased demand on our colleagues' time, not least of which is that too many members of the space science community are supported by soft money exclusively. Thus, the constant writing of proposals is often a matter of survival and NSF Program Officers are sometimes obliged to make funding decisions based on such concerns. Of course, up to a point, proposal pressure can help to maintain the competitiveness and dynamicism of a field but too much can certainly lead to abuses. The Panel observes that universities, institutes, and other organizations enjoy the fruits and funding (and overhead) that a vibrant space physics program brings to an academic institution yet all too often do not support these activities with faculty positions. This is a vicious circle because, besides placing greater burdens on NSF funding, the lack of university faculty positions means less access to graduate students and ultimately a diminishing younger space science population. In one way or another, the space physics community and the funding agencies will need to confront this problem.

Another possibility for relieving the pressure on the community might be to consider running a regular competition for new or entrant proposers and rely more on the accomplishments achieved (or not achieved) by more established proposers. The latter process might rely on a much shorter description of the research program and a synopsis of the proposers past funded program. We offer this as a possible modification to the present effective but somewhat burdensome review system and obviously many details remain to be addressed.

3.4.2 Questions concerning the implementation of the NSF Merit Review Criteria (intellectual merit and broader impacts) by STR reviewers and program officers.

IMPLEMENTATION OF NSF MERIT REVIEW CRITERIA	% REVIEWS
What percentage of *reviews* address the intellectual merit criterion? This was always addressed but not always in the marked box.	100% fraction
What percentage of *reviews* address the broader impacts criterion? This was often added more as an afterthought by a reviewer. Sometimes the broader impact was addressed already in the summary section. The Panel, probably like the reviewers themselves, were not completely clear about the importance of this criterion in judging the proposal.	75% fraction
What percentage of *review analyses* (Form 7's) comment on aspects of the intellectual merit criterion?	100% fraction
What percentage of *review analyses* (Form 7's) comment on aspects of the broader impacts criterion?	100% fraction

Discuss any concerns the COV has identified with respect to NSF's merit review system.

As we have noted already, the Program Director plays a vital role in ensuring the fairness, integrity, and efficiency of the review process. The Program Directors enjoy some discretion in deviating from the reviews, and have, in our opinion, used this to the advantage of science and the community. The Panel observes that some Program Directors are long term permanent staff while others are short term (on the order of 2 years) rotators. There are pros and cons to each position and we believe that it is important to retain and promote a mix because

Long term staffers :

- Know the system;
- Know the community;
- Can work efficiently, and
- Provide continuity over a long time period.

Conversely, long term Program Directors:

- May make it harder for younger people to break into NSF funded programs, and
- May make it harder for new ideas to get funded.

Short term rotators:

- Often introduce new ideas and fresh perspectives into the system, and
- Provide an opportunity for different research to get funded, and thereby enhance the vitality of the program.

Short term Program Directors can however:

- Miss opportunities initially because the system is new and unfamiliar.

Clearly, a mixed group of long term and short term Program Directors offers great advantages to UARS, seen by the Panel, and the community has benefited.

3.4.3 Questions concerning the selection of STR reviewers.

SELECTION OF REVIEWERS	YES , NO Or DATA NOT AVAILABLE
Did the program make use of an adequate number of reviewers for a balanced review? **Comments:** In most cases, an adequate number of reviewers was chosen. With some programs, write-in reviews were used to augment panel evaluations. However, as noted above, there were occasions in which reviewers did not always respond, leaving the program officer with too few expert reviewers. With the logistical difficulties faced by STR, Program Directors did not always chase up reviewers in as timely a manner a needed. Overall, the Panel was very impressed with the care exercised by the Program Directors in selecting suitable reviewers and using their views to guide their decisions.	Yes
Did the program make use of reviewers having appropriate expertise and/or qualifications? **Comments:** Yes, in most cases. Additionally, the Program Directors were cognizant of grass-roots movements within the community and chose reviewers who were frequently at the forefront of new developments.	Yes
Did the program make appropriate use of reviewers to reflect balance among characteristics such as geography, type of institution, and underrepresented groups? **Comments**: The Program Directors drew from a pool of reviewers that clearly represented the scientific community.	Yes
Did the program recognize and resolve conflicts of interest when appropriate? **Comments:** The Panel was extremely impressed with the fairness brought to the evaluation process by the Program Directors. Furthermore, the Program Directors within STR went out of their way to help those who submitted failed/unsupportable proposals by providing guidance and encouragement to the unsuccessful PI. This led, we believe, to high proportion of new PIs and under-represented groups within STR.	Yes
Did the program provide adequate documentation to justify actions taken? **Comments:** The documentation to support the decisions was of an extremely high standard and reveals very well the care that the Program Directors exercised in arriving at the judgment.	Yes

Discuss any concerns identified that are relevant to selection of reviewers in the space below.

3.4.4. Questions concerning the resulting portfolio of STR awards under review**.**

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE, OR DATA NOT AVAILABLE
Overall quality of the research and/or education projects supported by the program. **Comments:** The range of STR portfolio was most impressive, ranging from historical studies of the influence of the sun and cosmic rays on the Earth to very difficult and basic plasma physics questions. The scope ranged from pencil-and-paper theory to the development of sophisticated simulations and laboratory plasma experiments, and from the very abstract to the very applied. The portfolio was, in the Panel's judgment representative of the cutting edge of solar and space science, many of the proposals describing work that is clearly leading the world in its area. It is probable that the well-rounded STR research portfolio is the result of a vibrant community and the result of encouraging and open-minded Program Directors, who have made an effort to encourage participation by all segments and groups of our community.	Appropriate
Are awards appropriate in size and duration for the scope of the projects? **Comments:** The Panel would like to see more longer duration (4-5 year) awards. This may also reduce the demands placed on community. And of course, larger awards are needed since the program size has not kept pace with inflation. However, we are also conscious of the need, if the program funding level is increased, to also distribute the new money more widely since many deserving proposals are not funded because of financial stringencies. If past experience is any guide, we expect that the Program Directors will arrive at a fair balance.	No (see comments)
Does the program portfolio have an appropriate balance of • **High Risk Proposals** **Comments:** Yes. We encountered a number of proposals that received very mixed and contradictory reviews which required a difficult decision by the Program Director. The Panel was impressed by the judgment exercised by the Program Directors.	Appropriate

• **Multidisciplinary Proposals** **Comments:** The plasma science – DOE program supports a reasonable number of proposals. However, the Panel was surprised at how few MRI and ITR proposals were supported. It was unclear whether this was because the jackets for these proposals were unavailable.	Appropriate
• **Innovative Proposals** **Comments:** A reasonable number of innovative proposals are supported.	Appropriate
Of those awards reviewed by the committee, what percentage of projects address the integration of research and education? **Comments:** Many of the proposals supported either graduate students or post-docs. Fewer addressed directly undergraduate education, reflecting in part the numbers of university faculty. One proposal supports direct community outreach and education.	**Percentage** ~5% (undergraduate) ~70% (graduate and post-docs)

Discuss any concerns identified that are relevant to the quality of the projects or the balance of the portfolio in the space below.

Regarding the last point of the above Table, the Panel reiterates again that until a sizable part of the solar and space physics communities comprises university faculty, there will be little incentive to make serious and sincere efforts to develop undergraduate, graduate, and even K-12, educational programs that reflect these research disciplines. Outreach efforts are important, but these efforts are expensive and demanding and many researchers find difficulties funding much more than their research efforts. We suspect that the expectations of the Education and Human Resource Division are rather different from the educational and outreach aspirations of those who submit proposals to STR, and so we encourage more meaningful and productive interactions.

4.0 Outputs and Outcomes of the UARS Program

The COV elected to combine the individual programmatic reviews of outputs and outcomes from AER, MAG, UAF and STR into the single report that follows. The section is organized into the NSF categories of People, Ideas, and Tools.

In general, the COV felt that the UARS section was having a major impact on the field, through the maintenance of a broad ranging and rigorous core program and through the community-wide programs mentioned in Section 2.0, above. In general, the COV felt that the field was in a more healthy and vibrant state than for many years, due to the welcome leadership of UARS staff. NSF has every reason to be proud of this section and its recent accomplishments

The committee had a difficult time selecting individual highlights to demonstrate successful outcomes and the committee recommends that the interested reader also

review materials prepared by the UARS Program Directors. All the highlights listed below are considered significant.

4.1. People Goal Indicators

The general assessment of the COV is that the UARS Section has been successful in the goals associated with "People." The following sections provide individual highlights of work done under UARS sponsorship.

PEOPLE GOAL INDICATORS	PROGRAM INFORMATION
4.1.1. Development of well-prepared scientists, engineers or educators whose participation in NSF activities provides them with the capability to explore frontiers and challenges of the future:	
 *Figure 4.1.1. REU Student (center) arrives at the Greenland summit to assist in field maintenance of the Magnetometer Array on the Greenland Ice Cap (MAGIC) magnetometers.* The Upper Atmosphere Research Section supports seven sites at a variety of locations where students spend the summer working on a small research project supervised by a faculty person and then have to write a report on it at the end of the summer. Currently the sites are at Michigan, Alabama, Alaska, MIT, NCAR, NAIC, and NASA Goddard. A wide variety of topics in solar-terrestrial and atmospheric sciences is covered. Three students who went through the Michigan REU Site program actually got doctorate degrees in Atmospheric	**Grant Numbers** ATM-0097871 ATM-9820339 AST-0002457 AST-9619444 ATM-0000339

Sciences.	
Three named UARS programs (GEM, CEDAR, and SHINE) give graduate and undergraduate students opportunities to present and discuss their research at the premier professional workshops in their fields (see Figure 2.2, above). Between 100 and 150 graduate students and 10 to 20 undergraduates attend the annual CEDAR workshops, which have over 300 attendees. About 50 graduate students and several undergraduate students attend the annual GEM workshops, which have between 150 and 200 attendees. The annual workshops of the newly formed SHINE program have about 10 graduate students out of about 80 attendees. Both numbers are steadily growing.	**Grant Numbers** Multiple awards
In its pre-STC center phase, the Center for Integrated Space Weather Modeling (CISM) consortium organized a two-week space summer school designed to teach students about Space Weather modeling. Twenty graduate students attended the first school, which is now an annual event. The school is deemed by the students to be highly successful.	**Grant Number** ATM-0000950
Both the CEDAR and GEM programs sponsor named (CEDAR and GEM) post doctoral awards. CEDAR sponsors two per year and GEM one per year.	**Grant Number** Multiple awards
4.1.2. Improved science and mathematics performance for U.S. K-12 students involved in NSF activities:	
A National High School Space Weather Network was developed in partnership with the NOAA Space Environment Center in Boulder CO. Teachers from Alaska, Colorado, Texas, Florida, and New Hampshire integrated a search coil magnetometer kit, expressly developed for this purpose by UCLA and the Snap Circuits Division of Advanced Electronic Packaging, into their classrooms. These kits are similar to electronic "Legos" in that the electronic components (op/amps, resistors, capacitors) are "snapped together" onto a circuit board to make different systems (pre-amplifiers, filters etc.). A web-based curriculum is being developed this summer with participation of researchers in the UCLA Education School and a follow-on summer teacher workshop will be held in July at UCLA for the teachers for feedback and further training [Moldwin et al., 1999 and in prep, 2002].	**Grant Number** ATM-0196223

Several of the REU sites mentioned above run programs directed at K-12 teachers. Arecibo supports one teacher each summer. Haystack offers a Research Education for Teachers (RET) program which involves hosting two local secondary school teachers in residence. During the summer, the teachers develop classroom units which fit their education department guidelines. Their lesson plans are posted on the web for other teachers to adopt. In addition, teacher training workshops are supported by the Haystack Observatory staff.	**Grant Numbers** AST-0002457 AST-9619444
Haystack ran an extremely successful Young Scholars' Program, which was directed at 7th and 8th graders. This program introduced gifted middle schoolers to hands-on science experiments in the astronomy, geoscience, and atmospheric areas.	**Grant Number** AST-9619444
4.1.3. Professional development of the SMET instructional workforce involved in NSF activities:	
UARS funded Space Science Institute host summer workshops for teachers to develop science curricula for K-12.	ATM0095397
4.1.4. Contributions to development of a diverse workforce through participation of underrepresented groups (women, underrepresented minorities, persons with disabilities) in NSF activities:	
Two of the incoherent scatter radar facilities are in locations characterized by predominantly Hispanic populations. This provides an excellent source of inspiration for Hispanic students interested in scientific careers. Facility staff at Arecibo and Jicamarca have continually encouraged participation by local students in conducting experiments at the radar sites and pursuing higher degrees in electrical engineering and space science. This has resulted in an impressive list of Hispanic students who have gone on to successful careers in research and education. At Arecibo, a more formal program for bringing Puerto Rican students into the mainstream scientific establishment has been conducted over the past several years. The program brings promising undergraduate students at Puerto Rican universities to Cornell University where they take courses and learn about opportunities for research relating to either Arecibo or Jicamarca. Subsequent collaboration with researchers at the radar sites ensures their continued interest in ionospheric research and encourage them to continue the exchange program through graduate studies.	ATM9812007

Two grants have been made to Minority-Serving Institutions (MSI), ATM-0096095 (Univ. of Texas, El Paso, PI: R. Lopez) and ATM-0095013 (Prairie View A & M, PI: T.-S. Huang). All the programs in UARS contributed to the funding for the Integrated Space Weather Modeling consortium which has a strong education/outreach program that includes significant participation by underrepresented minorities.	ATM0096095 ATM0095013 ATM0000950
Female Scientists in Leadership Positions The Upper Atmosphere Research Section has a commitment to increasing diversity in the field and this is particularly evident in the encouragement and support for female scientists. In addition to the 28 individual grants awarded to women scientists during 1999-2001 (many of them new investigators), the UARS Section is proud of the relatively large number of female scientists occupying community leadership positions. These women are providing tremendous role models for junior scientists. A sample list of such scientists and their respective roles and accomplishments include, but is not limited to, the following: Dr. Margaret Kivelson: Elected to the National Academy of Sciences; Dr. Janet Luhmann, Editor-in-Chief, Journal of Geophysical Research – Space Physics, Co-PI CISM Science and Technology Center; Dr. Nancy Crooker, Secretary, Solar-Heliospheric Section of the American Geophysical Union and SHINE Workshop Coordinator, AGU Fellow; Dr. Judith Lean, Member of NSF Advisory Committee for the Geosciences, AGU Fellow; Dr. Maura Hagan, CEDAR Science Steering Committee Member, Chair SCOSTEP PSMOS program; Dr. Mary Hudson, AGU Macelwane medallist, AGU Fellow, GEM Steering Committee Chair and Co-PI of the CISM Science and Technology Center, Chair NAS Decadal Study for Magnetospheric-Ionospheric-Atmospheric interactions; Dr. Cassandra Fesen, CEDAR Steering Committee Chair; Dr. Pat Reiff, Co-PI, CISM Science and Technology Center; Dr. Roberta Johnson, Director, University Corporation for Atmospheric Research, Education and Outreach Office; Dr. Anthea Coster, Incoming Chair URSI Commission G; Dr. Delores Knipp, CEDAR and GEM Steering Committees; Drs. Gang Lu, Margaret Chen, Janet Kozyra, Campaign coordinators (GEM Steering Committee); Dr. Susan Avery, Director, CIRES; Councilor, AMS. Dr. Michelle Thomsen, AGU Fellow Dr. Shadia Habbal, Associate Editor of Journal of Geophysical Research – Space Physics. Dr. Maha Ashour-Abdalla, AGU Fellow	

4.1.5. Participation of NSF scientists and engineers in international studies, collaborations, or partnerships:	
CEDAR , GEM and SHINE Scientists are also heavily involved in equivalent international programs. In addition, the National Space Weather Program has a major international component. The SuperDARN radars represent an excellent example of international collaboration to provide a global perspective of convection electric fields at high latitudes. The Jicamarca Facility is located in Peru.	Multiple awards
4.1.6. Enhancement of undergraduate curricular, laboratory, or instructional infrastructure:	
The Global Change Laboratory at the University of Michigan has a dual function, involving support for both research caliber instruments and education of undergraduate and graduate students. An instrumentation curriculum has been developed.	**Grant Number** ATM-9512407
4.1.7.Awardee communication with the public in order to provide information about the process and benefits of NSF supported science and engineering activities:	
Space Science Institute develops very engaging displays on UARS phenomena (called Electric Space) for science museums. These displays tour the country from museum to museum.	ATM0095397
The atmospheric research facilities at Millstone Hill, Sondrestrom, Arecibo, and Jicamarca, each host a web site which provides information about the NSF supported science and engineering activities.	ATM-9911209 ATM-9714593 ATM-9813556 AST-9619444

4.2 COV Questions related to PEOPLE Areas of Emphasis

PEOPLE AREAS OF EMPHASIS	Demonstrates likelihood of strong performance in future? (Yes, No, Does Not Apply or Data Not Available)
4.2.1. K-12 Education -President's Math and Science Partnership	Does Not Apply

.2.2. Learning for the 21st Century: • **Centers for Learning and Teaching (CLT)** • **NSF Graduate Teaching Fellows in K-12 Education (GK-12)**	Does Not Apply
4.2.3. Broadening Participation • **Minority-Serving Institutions (MSI) programs** **Graduate Student Stipends** • **Increasing stipends for GRF, IGERT, and GK-12**	Does Not Apply

4.3. Ideas Goal Indicators

Significant intellectual advances have been made during the period of performance. The following materials summarize some of the most significant outcomes.

IDEAS INDICATORS	PROGRAM INFORMATION
4.3.1. Discoveries that expand the frontiers of science, engineering, or technology:	
(1) Joachim Raeder has been collaborating with Tim Fuller-Rowell to create a coupled model of the magnetosphere/ionosphere-thermosphere system. The Raeder MHD code (referred to as the MI model) has been coupled to Fuller-Rowell's CTIM code. The Bastille Day magnetic storm (July 14-16, 2000) was the largest magnetic storm of this solar cycle, and provided an excellent opportunity to test the results of the coupled model. The magnetic field on the dayside was strongly eroded and compressed, leaving three GOES satellites exposed to the solar wind. With a reliable and continuous solar wind and IMF data stream, real-time operational space weather forecasts would be possible with a model like this one. (2) Evidence for direct electrodynamic coupling between lightning discharges and the mesosphere/lower ionosphere was obtained through recently discovered spectacular luminous optical emissions known as red sprites, blue jets and elves. These phenomena were discovered by J. Winckler (who recently passed away) as late as 1990 and have received wide coverage in the press. One of the above grants was given as a Small Grant for Exploratory Research (SGER)	ATM0084483 ATM0118271

so that the PI (Pasko) and colleagues could quickly field radio and optical diagnostics in Puerto Rico to explore the physical processes involved in these emissions. This area of research has now been recognized as an important one because of the possible heating of the ambient electrons and rapid conductivity changes created by lightning-ionosphere interactions. The global significance of such phenomena needs to be evaluated in view of the fact that ~2000 thunderstorms may be active at any given time.	
4.3.2. Discoveries that contribute to the fundamental knowledge base:	
Atmospheric scientists at SRI International have found a gold mine in sky spectra taken at the W. M. Keck I telescope using the HIRES echelle spectrograph. The Keck I telescope is located on Mauna Kea. Don Osterbrock (Lick Observatory) had identified numerous atmospheric emission lines of the hydroxyl radical (OH) and oxygen molecule (O2). From collaborating Keck astronomers, he collected about 200 hours of sky spectra, producing the best available survey of optical emissions in the Earth's night airglow. The Keck/HIRES spectra have important implications both for understanding atmospheric processes and for dealing with near-earth night sky emissions that interfere with astronomical observations. Included is improved spectroscopy for O2, OH,and some atomic transitions; vibrational and rotational distributions of emissions from the Earth night airglow; and the surprising observation of strong emissions from atomic neon, argon, and xenon. These astronomical nightglow (sky) spectra are now available on line. The spectra cover the 400-900 nm range and are from the 200 roughly one-hour observations taken over the solar-minimum 1993-97 time period. The wavelength calibration is believed to be accurate to 0.0005 nm, and the resolution is about 0.02 nm at 750 nm. This is the best available nightglow spectrum in terms of wavelength coverage, spectral resolution, and simultaneity during each one-hour observation. Comparison of these spectra with others obtained near solar max show that in the latter case there are strong additional features that appear from ionospheric processes. NASA has just funded a National Virtual Aeronomical Observatory (NVAO) at SRI. The NVAO will collect such high-resolution survey spectra of optical emissions and make them available to students and researchers via the World Wide Web. It is important to note that the NVAO concept is founded on research supported by the Aeronomy Program.	ATM9714636, ATM9901101

Magnetic storms are basically defined by the buildup of the ring current. However, there remain controversies over the mechanisms that build up the ring current as well as the mechanisms for its decay. There are two major models for the way in which the ring current is built up. The first model posits that the storm is the aggregate of many individual substorms, each of which results in the injection of energetic particles into the ring current. An alternative model suggests that the storm is directly driven by the solar wind and the ring current build up is simply the result of enhanced convection. A study by Lui, McEntire and Baker, highlighted by Science magazine in the News of the Week section, Science, 293, p. 2370, Sept 28, 2001) suggests that both mechanisms can play a role. Energetic neutral atom imaging techniques were used to follow the build-up of the ring current and the polar cap potential drop determined by the SuperDARN radars was used to determine the strength of convection. The first increase in the ring current occurred when the AL index and the polar cap potential suddenly decreased. This was indicative of a substorm onset with a decrease in convection. The second major increase in the ENA counts corresponded to an increase in convection and a gradual decrease in AL rather than the sudden decrease one would expect from a substorm onset. It was during this period of enhanced convection that the major buildup in the symmetric ring current took place.	ATM0000219
4.3.3. Leadership in fostering newly developing or emerging areas:	

The tachocline is a relatively thin region in the solar interior (a few percent of the solar radius) characterized by coupled shear and penetrative overshoot which act to force deeper stably stratified motions. Such convective overshoot disturbs the upper portion of the stable radiative interior and is thought to generate gravity waves that propagate downward. The shear in the tachocline may induce overturning and breaking of the gravity waves, producing local patches and layers of anisotropic turbulence and mean flow acceleration. Three successive snapshots taken from a numerical simulation illustrate this process. Here one sees the evolution of the magnitude of the fluid vorticity displayed by three-dimensional volume rendering methods. The turbulence transports angular momentum, magnetic field, and important tracers, like lithium, across the stable barrier presented by the basic stratification. Dave Fritts and his group have for many years carried out work on the breaking of gravity waves in the Earth's atmosphere and their impact on zonal shear flows in the middle atmosphere. These same techniques and concepts may also be applied with great advantage to the study of the solar tachocline. The result is a non-traditional form of crosscutting research where ideas and concepts are shared between distinct disciplines to the benefit of both camps.	ATM9811938
4.3.4. Connections between discoveries and their use in service to society:	
NSF has provided partial support for the creation of the Community Coordinated Modeling Center (CCMC). The purpose of the CCMC is to act as a testbed to work at the interface between scientific research efforts and operational codes designed to improve space weather prediction. One of the products provided by the CCMC has been the first implementation of phase 2 of the GGCM (Geospace General Circulation Model). The CCMC currently has 2 MHD codes available for runs on request. These codes were provided by the University of Michigan (ATM-9980078, PI: C. Robert Clauer) and UCLA (ATM-9801937, PI: J. Raeder). The next step beyond phase 1 of the GGCM project was to provide facilities by which users could request runs of a magnetospheric model for specified conditions.	ATM9980078 ATM9801937 ATM9909921
4.3.5. Connections between discovery and learning or innovation:	

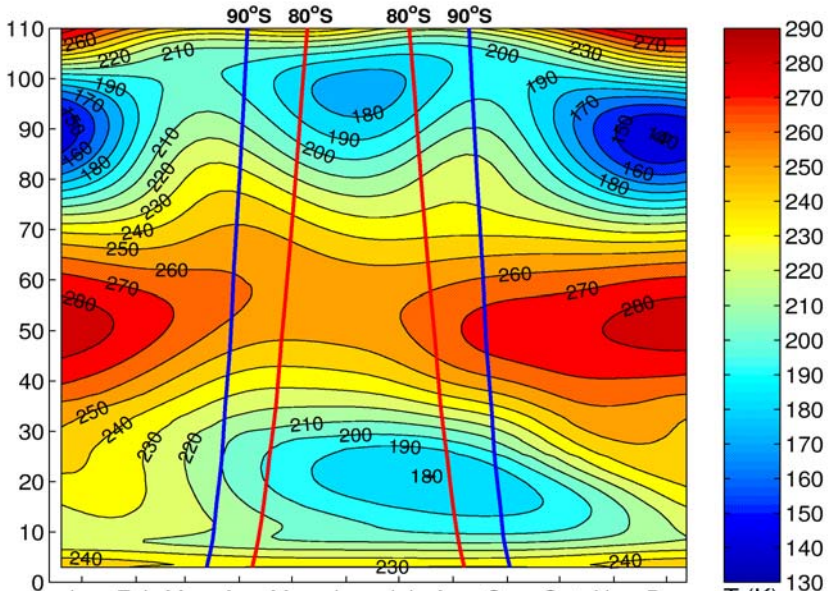


Figure 4.3.1. Weekly thermal structure measured from surface to 110km at the South Pole

MPS9612251

A multidisciplinary Optical Science and Engineering award, originally submitted to the Mathematical and Physical Sciences Directorate (hence an MPS number for the award), was for the development of a novel middle atmosphere temperature lidar that uses broadband tunable solid-state lasers and mesospheric iron as the fluorescence tracer. The project is a collaboration between U. of Illinois, Aerospace and NCAR. Temperature measurements of the upper stratosphere and mesosphere in winter above Antarctica will soon appear on the cover of the journal entitled Geophysical Research Letters. These measurements were made by Gardner's team in collaboration with Japanese scientists during the winters of 2000 and 2001. Both groups report that temperatures are much colder than those observed at similar latitudes during winter in the Northern Hemisphere and predicted by current models. Their results suggest that these differences may be caused by hemispherical differences in gravity wave and planetary wave forcing of the meridional circulation system, which affects compressional heating of the middle atmosphere over the wintertime polar caps. This may require modifications in the gravity wave forcing term in TIME-GCM, the most widely used upper atmospheric general circulation model developed by Ray Roble and colleagues at NCAR.

4.3.5. Partnerships that enable the flow of ideas among the academic, public or private sectors.

The Space Science Institute has been funded in part by the Magnetospheric Physics program and in part by EHR to develop an outreach program to educate the public about space physics and the National Space Weather Program. They have developed a sophisticated portable exhibit called “Electric Space” which is taken to different museums around the U.S. They are now developing a smaller mini-exhibit called “Space Weather Center”. In addition to their exhibits they prepare teaching materials for K-12 classroom purposes and have a web site devoted to space physics and space weather. The Electric Space exhibit receives funding from NSF and NASA.	ATM9615642

4.4. COV Questions related to IDEAS Areas of Emphasis

IDEAS AREAS OF EMPHASIS	Demonstrates likelihood of strong performance in future? Select one: Yes, No, Does Not Apply or Data Not Available
4.4.1. Biocomplexity in the Environment	
	Does Not Apply
4.4.2. Information Technology Research	
The purpose of the Space Physics and Aeronomy Research Collaboratory (SPARC) project is to design, develop, deploy, and evaluate Internet-based technology that helps space scientists work together in collaborative studies of space and upper atmospheric science. The SPARC team includes an international community of space, computer, and behavioral scientists. The Upper Atmospheric Research Collaboratory (UARC), from which SPARC has developed, focused on internet-based collaborative interactions during real-time data acquisition, usually from a single site in Greenland (Sondre Stromfjord). Over the last few years of the UARC project, a larger number of ground-based instruments and satellites were included as well as large-scale computational models of the upper atmosphere. The SPARC project now includes a wider range of participating instruments and models corresponding to an expanded emphasis on science topics spanning the Earth's magnetosphere - ionosphere - thermosphere system. It has already revolutionized the way real-time experimental	ATM9216848 ATM9873025

space physics and aeronomy campaigns are being conducted worldwide and has set a new standard for international cooperation between different ground-based facilities and satellite observations, in particular, from ISTP. More than 200 data sources and model outputs are currently available through SPARC. SPARC has supported activities of the September 1999 International Space Weather Campaign organized under the auspices of the S-RAMP program of SCOSTEP. SPARC is also an excellent educational tool and has extensive Outreach WebPages attached to it. UARC, SPARC's predecessor, has been inducted into Smithsonian Institution's Permanent Research Collection on Information Technology Innovation. The Knowledge and Distributed Intelligence (KDI) program funds the SPARC project, while UARC was a collaborative activity of the Computer Sciences Directorate and the Upper Atmosphere Research Section.	
4.4.3. Nanoscale Science and Engineering	
	Does Not Apply
4.4.4. Interdisciplinary mathematics	
Computational studies of magnetohydrodynamic (MHD) turbulence require the resolution of intense, thin, current sheets, which are the dominant sites of energy dissipation and plasma heating. It is prohibitive to carry out numerical simulations with uniform fine-scale resolution and with sufficient domain sizes to capture the large-scale dynamics. Amitava Bhattacharjee has been developing “smart” codes, which place the resolution where it is needed. They make use of a technique known as Adaptive Mesh Refinement (AMR). AMR naturally places fine grids (to the level of refinement required by the Reynolds and Lundquist numbers) where the large-scale dynamics forces steep gradients.	ATM0001317

4.5. Tools Goal Indicators

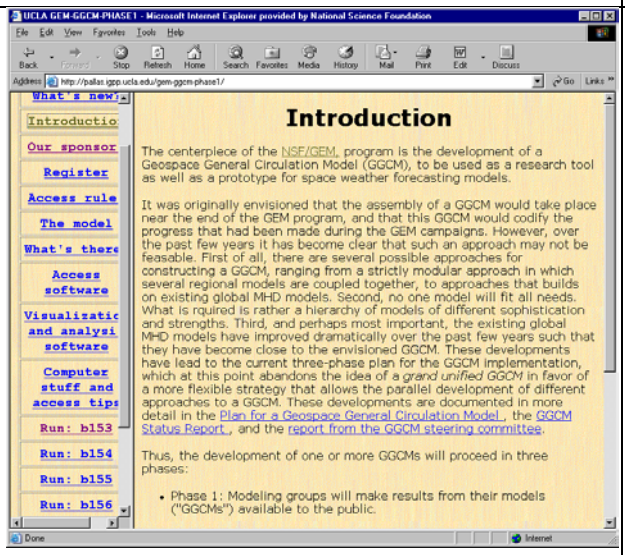
The COV has interpreted the term “infrastructure” broadly, including in its purview the intellectual infrastructure afforded the field by, for example, the community programs GEM. CEDAR, SHINE, NSWP.

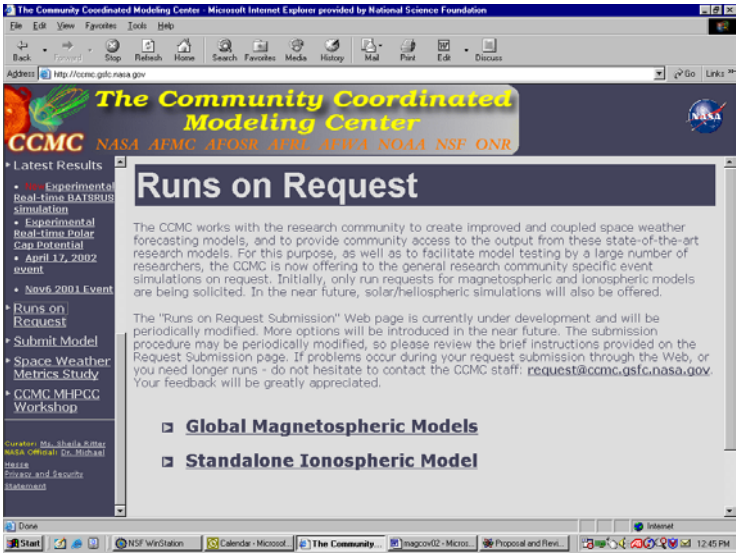
TOOLS INDICATORS	PROGRAM INFORMATION
4.5.1. Provision of facilities, databases or other infrastructure that enable discoveries or enhance productivity by NSF research or education communities:	
The UARS has a specific program, the Upper Atmospheric Facilities Program, which promotes the cooperation and coordination of the four U. S. radar facilities (Jicamarca Radio Observatory in Peru, the Arecibo Observatory in Puerto Rico, the Millstone Hill Radar in Massachusetts, and the Sondrestrom Radar in Greenland). This program is extremely highly regarded by the Panel and is reviewed separately above, so we do not discuss it further here. The radar facilities constitute important, well maintained and scientifically productive components of NSF's infrastructure for upper atmosphere research.	**COOPERATIVE AGREEMENT NUMBERS** ATM-9911209 ATM-9714593 ATM-9813556 AST-9619444
The GEM, CEDAR, SHINE and Space Weather programs should also be regarded as infrastructure since they form umbrella bodies under which large sections of the upper atmospheric community congregate. The tremendous success of these programs reflects both the leadership role of the NSF in developing a vibrant community of scientists and the responsiveness of the NSF to the scientific community in its determination of new research directions. The "intellectual infrastructure" of GEM, CEDAR, SHINE, and Space Weather has led to the promotion of annual "grand challenge projects," and to the organization of annual meetings. Besides the dissemination of research results and the exchange of new ideas, the annual meetings act as community forums (the recent Space Science Decadal Survey used these meetings to good effect to determine the views of the research community), and encourage the attendance of graduate students (>100 at the most recent CEDAR meeting). The Space Weather program has pioneered a new direction of research, and, by recognizing the impact of the program on both fundamental physical questions and society, implicitly increased the potential reach and productivity of space science. These programs are true gems within the UARS and exemplify the NSF aspirations of enabling discoveries, enhancing research productivity, and expanding the education community.	**GRANT NUMBERS** Multiple awards

A Measure of the Sun and Long-term Climate Change. The main difficulties with precise measurement of the solar diameter are: (1) the atmospheric "seeing" is systemic and one cannot simply decrease its effects by making the same measurement several times, (2) the solar diameter is large in angular terms and is affected by optical aberrations that increase with distance from the optical axis, and (3) calibration is difficult. Sabatino Sofia and his collaborators have developed a balloon-borne instrument called the Solar Disk Sextant (SDS), which largely circumvents each of these difficulties through innovative design and by observing the sun from the 3 mbar pressure level of the atmosphere. Flights of the instrument, shown in the accompanying figure, have been made from Fort Sumner, New Mexico, in the Fall of 1992, 1994, 1995, 1996 and 2001 (Figure 4.3.2). The principal objective of the work is in terms of the solar driving of climate change. That is, to understand the details of the physical mechanism for solar variability on decades to centuries, and to measure and understand the logarithmic derivative of the solar radius with respect to luminosity. Once this is determined, historical eclipse data extending back in time for some 250 years (which provide the solar radius) can be inverted to infer the solar luminosity. This will not only greatly extend the record of solar irradiance variations, but will also be invaluable to climate modelers.	ATM-9900568, PI: Sabatino Sofia, Yale University

 **Figure 4.3.2. Launch of the Solar Disk Sextant instrument from Fort Sumner, New Mexico.** Atmospheric scientists at SRI International have found a gold mine in sky spectra taken at the W. M. Keck I telescope using the HIRES echelle spectrograph. The Keck I telescope is located on Mauna kea, Hawaii. Don Osterrock (Lick Observatory) had identified numerous atmospheric emission lines of the hydroxyl radical (OH) and oxygen molecule (O2). From collaborating Keck astronomers, he collected about 200 hours of sky spectra, producing the best available survey of optical emissions in the Earth's nightglow. The Keck/HIRES spectra have important implications for understanding atmospheric processes and for dealing with near-earth night sky emissions that interfere with astronomical observations. Included is improved spectroscopy for O2, OH and some atomic transitions; vibrational and rotational distributions of emissions form the Earth night airglow; and the surprising distributions of strong emissions from atomic neaon, argon, and zenon. These astronomical nightglow (sky) spectra are now available on line. The spectra cover the 400-900 nm range. The wavelength calibration is believed to be accurate to 0.0005 nm, and the resolution is about 0.02 nm at 750 nm. This is thought to be the best available nightglow spectrum in terms of wavelength coverage and spectral resolution. NASA has just funded a National Virtual Aeronomical Observatory (NVAO) at SRI. The NVAO will collect such high-resolution spectra and make them available to students and researchers via the web. It is important to note that the NVAO concept is founded on research supported by the UARS/AER program.	ATM-9714636 and ATM-9901101, PI: T. Slanger, SRI International
All the UARS programs support long-term datasets of one kind or another. These datasets range from long-term monitoring of solar irradiance (both current and historical), solar disk activity, upper atmospheric conditions and indices, cosmic ray influences, etc. These records form an invaluable record and are available to the entire	ATM-9714636 ATM-9900568 ATM-9628862 ATM-9632323 ATM-0000575

scientific community. The datasets are used worldwide by the scientific community. In this, the Program Directors have been conscious of the need to preserve the collection of these data sets, and to ensure that the sets are available to the widest possible community. New dataset initiatives have also been initiated. The sky spectra obtained using the W. M. Keck I telescope described above represent another example of a database enabled through UARS funding. These spectra can be used for many future aeronomic studies.	ATM-003198
4.5.2. Provision of broadly accessible facilities, databases or other infrastructure that are widely shared by NSF research or education communities:	
UARS has been instrumental in developing and managing very large datasets and these sets are utilized by a large part of the space physics and aeronomy community. The datasets themselves are mutating into a variety of forms, and are taking full advantage of the rapid advances in computational power. Examples of different forms of such databases are described below, these ranging from the "typical" acquisition of huge quantities of data, the development of systems that allow for real-time dissemination and probing of data, the development of multi-instrument-based data sets, and the development of simulation/model-based datasets generated by highly sophisticated and "expensive" numerical codes. All these forms of datasets are made available to the broad scientific community via the internet. The Panel views with some concern the relatively poor interaction between groups developing very large data sets and other NSF programs such as MRI and ITR. There is no doubt that many of the UARS groups would benefit considerably with additional support for hardware or in the development and implementation of sophisticated algorithms. Unfortunately, the practical application and development of information technology appears not to meet the possibly more abstract criteria on which the current ITR program is based, and this makes it difficult for UARS PIs to be competitive in these programs.	
A multi-national effort is generating a database for the latitudinal distribution of ionospheric plasma and the occurrence of plasma irregularities in the equatorial region, using a large network of GPS total electron content (TEC), optical, radio, and radar systems in the western South American sector. The database will help scientists determine an ionospheric precursor which can be used to forecast plasma irregularities and this is of great importance for the disruption of communication and navigation systems. Another form of dataset, created at UCLA, is based on MHD simulations of the magnetospheric response to 8 IMF/solar wind "standard" conditions. Such simulation-based datasets will come to	**GRANT NUMBERS** ATM-0123560 ATM-9801937 ATM-0000315

assume increasing importance as numerical simulations become increasingly more sophisticated, allowing observations to be compared directly to very complex model output. Finally, the STR program is supporting a global neutron monitor network comprising 9 stationary monitors, 2 transportable ship-borne monitors, and spacecraft data. This represents a multi-agency, multi-national collaboration headed by the NSF and, in monitoring the flux of interplanetary and solar cosmic rays, has a practical impact on space weather forecasting.	
Geospace General Circulation Model. One of the goals of the GEM program was to provide a Geospace General Circulation Model (GGCM) to the space physics community. The first phase of the GGCM project was to provide a set of models for some well defined, standard conditions. One repository of models has been created at UCLA. Detailed results from an MHD simulation are available for the 8 fixed IMF/solar wind standard conditions. In addition a number of other fixed solar wind/IMF conditions are available as well as simulations from the GEM substorm challenge. 	ATM-9801937, PI: J. Raeder, UCLA



The next step beyond phase 1 of the GGCM project was to provide facilities by which users could request runs of a magnetospheric model for specified conditions. NSF has provided partial support for the creation of the Community Coordinated Modeling Center (CCMC). One of the products provided by the CCMC has been the first implementation of phase 2 of the GGCM. The CCMC currently has 2 MHD codes available for runs on request. These codes were provided by the University of Michigan.

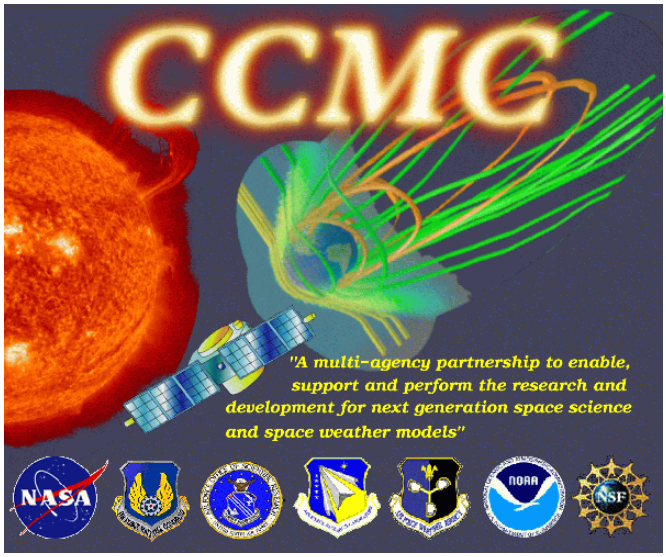
ATM-9909921, PI: M. Hesse, GSFC/NASA
ATM-9980078, PI: C. Robert Clauer; and UCLA
ATM-9801937

The Upper Atmospheric Research Collaboratory (UARC), an outgrowth of the Space Physics and Aeronomy Collaboratory (SPARC), has used internet-based technology for real-time collaborative work and data acquisition from many ground-based instruments and satellite probes as well as incorporating large-scale computational model output. UARC involved collaboration between the Computer Sciences Directorate and the Upper Atmospheric Research Section. This project has greatly expanded the participation of the atmospheric sciences community in real-time observational plasma physics campaigns involving the Earth's magnetosphere-ionosphere-thermosphere system.

GRANT NUMBERS
ATM-9873025

4.5.3. Partnerships, e.g., with other federal agencies, national laboratories, or other nations to support and enable development of large facilities and infrastructure projects:

NSWP). The NSWP represents a new intellectual infrastructure. Since its inception the NSWP has been the source of many new grants and is the premier vehicle for transitioning basic research to the frontline of space environment forecasting. Members of the SHINE, GEM and CEDAR communities are active participants in this new endeavor.



The Community Coordinated Modeling Center (CCMC) is an example of NSF support providing new tools for the, ionospheric, magnetospheric and space weather community by implementing the goals of phase 2 of the GGCM. The CCMC is also a prime example of the effective coordination of support from many agencies. The CCMC receives support from NSF, NASA, AFOSR, AFRL, AF Materiel Command (AFMC), AF Weather Agency (AFWA), NOAA, and ONR.

The AER and UAF sections have fostered ongoing collaboration with NASA involving their TIMED satellite program. The program has raised great scientific expectations in the community doing multi-technique ground-based observations, as they, for the first time, feel an integrated part of a NASA science mission. The joint data bases and model upgrades resulting from this coordination are expected to shed much light on the relatively unexplored region of the Earth's atmosphere between 60-180 km. This region is also the one in which significant atmospheric changes are underway, perhaps due to anthropogenic sources, such as the appearance of noctilucent clouds at relatively low latitudes over the Continental US. Thus both cutting-edge science and societal benefits are expected to emerge as a result of this coordination. Part of that CEDAR support to TIMED will come through the Maui/MALT Program. AFOSR has made it possible for CEDAR PIs to utilize the 3.7 m optical telescope on Mount Haleakala.

NSWPATM-9909921: ATM-0004380,
PI: B. Fejer, Utah State U.

CCMC: ATM-9909921,
PI: M. Hesse,

Maui/MALT: ATM-0003198,
PI: C. Gardner, U. of Illinois

Space Weather Storms: Under NSF sponsorship, CAREER award PI Haimin Wang has organized a network of observatories around the globe to monitor the solar disk in the Balmer-α line of hydrogen. The five stations of the network are located at the Big Bear Solar Observatory (California), Kanzelhohe Solar Observatory (Austria), Catania Astrophysical Observatory (Italy), Yunnan Observatory and Huairou Solar Observatory (both China). The global network observes the sun continuously (weather permitting) with 1-minute temporal cadence and 750 km spatial resolution. From such a synoptic program one can observe filament eruptions and forecast the onset of geomagnetic storms. Anomalous cosmic rays: These energetic particles have long been thought to have a source in the interstellar medium. Recent theory advances and data analysis of Ulysses spacecraft observations suggest a seed population near the Sun. The Solar Terrestrial Relations section of UARS is funding further investigation of Sun-solar wind interface as a source of these energetic particles. This effort combines NSF support with analysis of data sets obtained by the European Space Agency.	Space Storms: ATM-0076602, PI: Haimin Wang, Cosmic Rays: ATM-0100659 PI: G. Gloeckler
4.5.4. Use of the Internet to make SMET information available to the NSF research or education communities:	
4.5.5. Development, management, or utilization of very large data sets and information-bases:	
4.5.6. Development of information and policy analyses that contribute to the effective use of science and engineering resources:	
Policy analysis for space weather impacts on power systems, satellite communications and navigations systems and on human resources in space are being carried out. This research, which has great impact on society at large, will assess technical vulnerabilities, examine economic and societal consequences of space weather, and will work with federal agencies such as NOAA, DOD, FEMA and NASA to enhance existing plans to deal with emergencies. Furthermore, it will identify new roles for the media in broadcasting public awareness of practical space weather effects.	ATM-0128753 PI: W. Hooke, American Meteorological Society

The UARS Program is making very effective use of tools. The AMISR project has a very high priority for UARS and the scientific community. The COV urges NSF/GEO to expedite support for this well defined and mature (mid-size) MRE project.

4.6 COV Questions related to TOOLS Areas of Emphasis

TOOLS AREAS OF INVESTMENTS	Demonstrates likelihood of strong performance in future? Select one: Yes, No, Does Not Apply or Data Not Available
4.6.1. Major Research Equipment (MRE)	
	Does Not Apply
4.6.2. Major Research Instrumentation (MRI) Program	
An MRI grant was awarded to Dartmouth College for the acquisition of an Origin 2000 computer system for use in space physics modeling. The equipment has been used by a number of PIs in the Magnetospheric Physics Program (e.g. R. Denton, J. Lyon, M. Wiltberger, M. Hudson, A. Streltsov). The Magnetospheric Physics Program also provided partial support for the development of the Large Plasma Device (LAPD) at UCLA, and it continues to provide support for laboratory plasma experimental equipment at West Virginia University through numerous grants.	GRANT NUMBERS ATM-9977411 ATM-0075916
4.6.3. Science & Engineering information, reports, and databases **Comments:**	
	Does not Apply
4.6.4. Scientific databases and tools for using them **Comments:**	
	Does Not Apply

4.6.5. NATIONAL SMETE DIGITAL LIBRARY	
	Does not Apply

4.7 NSF would appreciate your comments for improvement of the COV review process, format and report template.

The COV process would be improved if jackets were stored and retrieved electronically.

The COV believes that the question regarding the balance of high risk, multidisciplinary, and innovative proposals is not well posed. We believe that essentially all funded projects are innovative and that there is a wealth of multi-disciplinary projects. Program directors actively solicit cross-disciplinary projects from their respective communities, however their numbers remain small. There is no clear definition of high-risk projects. Thus this is a difficult assessment for reviewers and COV members to make. The Program Directors are in the best position to identify such proposals. We find some examples of such identifications in the COV material. But, as a committee, we cannot judge the level of balance in this category. We recommend that UARS find a way to flag and identify such proposals more systematically as an aid in the review process.

5.0 Additional Recommendations

1) Getting more faculty positions

Too many members of the space science community are supported by soft money exclusively. Thus, the constant writing of proposals is often a matter of survival and NSF Program Officers are sometimes obliged to make funding decisions based on such concerns. Of course, up to a point, proposal pressure can help maintain a competitive and dynamic field, but too much can certainly lead to abuses. The Panel observes that universities, institutes, and other organizations enjoy the fruits and funding (and overhead) that a vibrant space physics program brings to an academic institution, yet all too often do not support these activities with faculty positions. This is a vicious circle because, besides placing greater burdens on NSF funding, the lack of university faculty positions means less access to graduate students and ultimately a diminishing younger space science population. In one way or another, the space physics community and the funding agencies will need to confront this problem. The NSF may want to consider a few grants covering several years to universities that agree to creating tenured faculty positions in UARS science, or some similar incentive.

2) IPAs and program heads - possibly have some work remotely

NSF has been maintaining a good mix of permanent and rotating staff as program directors. The rotation of the Program Directors has had the salutary effect of bringing fresh ideas, vitality, new contacts and areas of expertise to the NSF. It may also be advisable to encourage the permanent staff to take sabbaticals at research institutions to help them maintain their scientific acuity. The NSF may also want to consider allowing rotating staff to work remotely for a large fraction of their time.

3) Replacing infrastructure - make funding available to update

One overarching issue that we saw in many of the facility reports were comments addressing aging infrastructure, fragile and hard-to-replace klystrons, difficult equipment upgrades, etc. Robust infrastructure is critical to the current and future operations of these sites and many university laboratories, as well as for the future of science in this country as a whole. We believe that the NSF's equipment and research instrumentation funding would be better distributed at the discipline officer level to promote flexibility and efficiency in addressing this problem. In the age of microelectronics and nanotechnology, NSF should be a leader in stimulating the development of next-generation equipment and research facilities. In particular, we recommend that the NSF provide UARS additional funds to entertain proposals related to developing new scientific instrumentation and infrastructure for space science research.

4) Reviewer response criteria should be expanded to include the categories: risk, multi-disciplinary and innovation.

These aspects should be emphasized as positive characteristics of a proposal. The program director should emphasize in review solicitations the importance of rating the review in these categories (breadth, impact, risk, multi-disciplinary innovation).

5) Mail-in reviewers

The COV recommends that UARS program officers redouble their efforts to get a higher level of return from the mail-in reviewers. One suggestion would be for the program officers to make presentations at national meetings reinforcing some of the observations made in this review. Another approach would be to cultivate junior scientists as reviewers, since apparently the rate of return in higher for people in the earlier part of their careers and the reviews from early career scientists are often comprehensive and thorough.

7) K-12 Education

We recommend that the UARS develop a strategic plan for education and outreach activities that builds on the obviously growing community interest and momentum and ensures that such efforts are more than a secondary byproduct of the core research, Ideally, UARS education and outreach activities would be leveraged and informed by support from the education and human resources directorate..