COMMITTEE OF VISITORS
UPPER ATMOSPHERE RESEARCH SECTION
DIVISION OF ATMOSPHERIC SCIENCES
NATIONAL SCIENCE FOUNDATION
July 22-24, 2008

UARS COV REPORT

1. SUMMARY OF FINDINGS

The COV is very impressed by the impact, integrity and effectiveness of UARS. In spite of its relatively small budget UARS has a major impact on the Nation's geospace environment research effort extending from the mesosphere to the Sun. It is safe to say that UARS provides the intellectual leadership in this area through the community organized CEDAR, GEM and SHINE programs as well as through its leadership of the National Space Weather Program. It also plays a leading role in the development of new observing technologies through the Upper Atmospheric Facilities program.

Overall, the UARS program is well balanced, well managed and highly respected by the space science community. It is forward looking, trend setting and it has a major impact on the entire space physics community. With this in mind the suggestions and criticisms provided by the COV need to be taken as our attempt to make an already excellent program even better.

The main findings of the COV (in no particular order) are the following:

Program balance. Overall, the UARS program is well balanced. The COV is satisfied with the balance between the sub-disciplines, but notes that Space Weather is a distinct cross-cutting area and it might make sense to create a new program element for space weather. The balance between the observational programs (including major UARS facilities and smaller instruments like magnetometer chains, optical instruments and neutron monitors) is relatively stable, but the COV recommends that a UARS-wide review of this balance be carried out. The balance between new and continuing awards is healthy. UARS is doing a very good job in supporting young investigators, postdocs and graduate students. The COV is very pleased with the undergraduate education programs (such as REU and RET).

FDSS. The COV considers the Faculty Development in Space Sciences program the most important new initiative in UARS. It grew out of the recommendations of the NRC Decadal Study for Solar and Space Physics (NRC 2003). While it is too early to judge the success of this program, the early results are very promising. All eight positions were filled with talented young scientists and they are nicely progressing toward their tenure review. Some of the new hires are rising stars in their communities and starting to take leadership positions in the CEDAR, GEM and

SHINE communities. The COV strongly recommends the continuation of the FDSS program in a staggered manner at the discretion of UARS. The FDSS program is critical for the future health of the space science community, since there is a noticeable decline in university faculty with space science interest.

Interdisciplinary research. The new frontiers of science and engineering are clearly at the intersection of several traditional disciplines. This trend is well recognized by the NSF leadership and the Agency is creating several high profile, well funded agency-wide initiatives (like MRI, MREFC, CMG or CDI). It is very important to keep informing the community of funding opportunities that lie outside of UARS. The program directors are doing this, but we stress that they should continue to inform and educate the community about these funding opportunities offered by agency-wide programs.

Even though the number of women and underrepresented minorities in UARS grants are small, the balance seems to be appropriate considering the pool of potential applicants. For example, CAREER grants that were awarded to women counted for half of the total in the Magnetosphere program even though their percentage in the community is relatively small.

Panels vs. mail reviews. There is a general concern in the UARS community (also expressed by the 2005 COV) that there is a tendency to have more review panels. They are appropriate for focused areas, but not necessarily for the broad core programs. The community has more trust in the integrity of the Program Directors and it favors mail reviews. An example can be found in proposal 0535468 (PI is Mills). One of the mail reviews made a negative comment that the proposal did not mention the impact of water from the space shuttle on polar mesospheric clouds. The panel repeated this as one of several concerns about the proposed study. The role of shuttle water in PMCs is extremely controversial. It has been presented in conferences, published, and is strongly promoted by some people in the community. However, many others find that the evidence is very weak and that the hypothesis does not take into account basic aspects of mesospheric variability and transport. In fact, the inclusion of a discussion about shuttle water in the proposal would have been likely to prejudice some potential reviewers against the proposal. This example shows a case in which one review has swayed the entire panel in a way that would not have happened if the panel members themselves had been experts in mesospheric climate. It is also recommended that potential reviewers be contacted before proposals are assigned to them. In our view this would make the reviewers more accountable and they would feel more obligated to finish the reviews on time.

College of Reviewers. An additional suggestion is to form a "College of Reviewers" with rotating one or two year membership. Each member of the "College of Reviewers" would agree to carry out 5 to 10 mail reviews a year. This would make the mail review process more manageable and would provide a clear "community service" for the members that can be listed in promotion or tenure materials.

Submission deadlines. The COV is concerned about the effect of rolling submission deadlines on the core programs. There were a few very highly rated proposals (including one with all Excellents) that were declined due to the lack of available funds. The COV recommends that UARS should consider the possibility of annual submission deadlines to the core programs (this can be different for the different programs).

Additional Program Director. UARS presently has five Program Directors. The COV is extremely pleased with their devotion, integrity, professionalism and enthusiastic support of the UARS community. On behalf of our community the COV wishes to thank all of them (and needless to say, the Section Head too) for the excellent job they are doing. It appears to the COV that due to increased proposal pressure in the very successful CubeSat and Space Weather competition areas it would be very beneficial to have one more PD in UARS. This would also make it possible for the PDs to conduct independent research and maintain closer contacts with their communities.

Make UARS a Division. The COV recommends that the Upper Atmosphere Section be changed and a new Division be created within the Geosciences Directorate. This has been also suggested by the NSWP Assessment Report (FCM-R24-2006): "The solar and solar-terrestrial program elements of the NSF should be managed as one, possibly division level, program so as to have a unified overview of both the basic research and space weather elements."

The Atmospheric Sciences Division has served the UARS community well over the last decades, but recent developments (such as the success and growth of the National Space Weather Program) necessitates the consideration of creating a Division of "Geospace Sciences" within the Geosciences Directorate. The scope of UARS is clearly much broader than just the upper atmosphere. A much more appropriate name would be "Division of Geospace Sciences." With the creation of a new division several problems would be solved:

1. Improve synergism within Geosciences. The organization of the Geosciences Directorate follows the main "spheres" of our planet: solid "sphere" (interior and land), fluid "sphere," gas "sphere." UARS deals with the fourth sphere of geosciences: the geo-"sphere." A "Division of Geospace Sciences" would be an appropriate addition that recognizes the importance of the space environment. It also recognizes the fourth state of matter: plasma.

2. Improve synergism with the organization of the geosciences community. The main professional organization of geosciences, the American Geophysical Union, is self-organized by the community and its structure reflects the structure and sub-disciplines of geosciences. AGU has 11 Sections, including Atmospheric Sciences, Ocean Sciences, Space Physics and Aeronomy and several sections representing solid Earth. A "Division of Geospace Sciences" would bring the organization of the Geosciences Directorate more in line with the community's organization.

3. A home for solar physics. Presently solar physics is split between Astronomy and UARS. Most of the large solar facilities are in AST (like NSO), while others are in UARS. The Sun is obviously a star, but it is also a variable source of energy for Earth and its environment. At present, most of the solar research funded by NSF is supported by UARS and not AST. In our opinion, bringing solar physics to the Geosciences Directorate would make a lot of sense. This would mean transferring the solar facilities (including the planned ATST) to UARS.

4. Increase the visibility of space science. Presently space science is a small (one might say marginal) element even in the Geosciences Directorate. This is clearly reflected by the fact that the new "Geovision" document all but ignores space science and the importance of space weather. A "Division of Geospace Sciences" would give higher profile (and bigger voice) to space science and space weather research.

5. Improve interagency collaboration. Space science at NASA, the most important partner agency, is at the Division level. It clearly hinders interagency collaboration that the UARS Section Head cannot negotiate as equal partner with the Director of the Heliophysics Division of NASA. This problem would be resolved by the creation of a "Division of Geospace Sciences."

2. PROCESS

COV members were appointed by NSF to examine the performance of the UARS section in the period 2005 to 2007. The membership was the following:

Name	Affiliation	Program Element
Tamas Gombosi, Chair	University of Michigan	
Sarbani Basu	Yale University	STR
Diego Janches	NW Res. Associates, CoRA	UAF
Margaret Kivelson	UCLA	MAG
Robert Clauer	Nat. Inst. of Aeronautics	MAG
Kent Miller	AFOSR	UAF
Hans Nielsen	University of Alaska	AER
Wayne Scales	Virginia Polytechnic Inst.	AER
David Sibeck	NASA GSFC	MAG
Anne Smith	NCAR	AER
Leonard Strachan	Harvard-Smithsonian	STR

COV reviews provide NSF with external expert judgments in two areas:

1. Assessments of the quality and integrity of program operations and program-level technical and managerial matters pertaining to proposal decisions; and

2. Comments on how the results generated by awardees have contributed to the attainment of NSF's mission and strategic goals.

The committee was provided with a set of specific questions on proposal processing and program management. Answering these questions through investigations of proposal jackets and the compilation of statistics constituted the main activity of the visit. In the weeks before the meeting, committee members were assigned "jackets" from a list of proposals processed by UARS in the period 2005 to 2007. About half the selected jackets were selected by the Program Directors, while the second half of them were selected by the COV Chair. A few additional jackets were selected by the COV members themselves. The jackets for the selected proposals were loaded into the Electronic COV module and were available for committee use prior to our arrival to NSF.

Statistics data and a copy of the previous COV report on UARS were also provided ahead of meeting. There is no doubt that being able to become familiar with this material helped the committee to get started quickly on the first day.

On the morning of the first day, the committee was welcomed by Tim Kileen and Jarvis Moyers. Their brief remarks were followed by presentations by Section Leader Richard Behnke, and Program Directors Cassandra Fesen, Kile Baker, Paul Bellaire and Robert Robinson. These presentations provided important data and context bringing all committee members up to date on achievements and issues in the section and its programs.

The COV spent significant time in breakout groups of two or three members representing the four individual programs. The breakout groups generated answers to Parts A and B of the questions provided by NSF. Each breakout group provided a complete set of answers to the questions for the Chair to use in compiling the final report. The whole committee contributed to the formulation of the list of collective findings and assisted the Chair in writing the overall conclusions in this report.

The COV was uniformly pleased with the support provided by UARS staff for its work prior to and during the meeting. Efficient support was provided during the entire COV process by Program Director Therese Moretto. Requests for information were processed promptly, speeding the committee's work. The COV benefited greatly from the ease of access to data and materials through the Electronic COV software and database.

A preliminary verbal report was provided to Jarvis Moyers and the UARS staff at the end of the COV visit.

3. ADDITIONAL FINDINGS

In this section we list amore findings in addition to the ones given in Section 1. Clearly, this additional findings are less important than the ones given earlier. The additional findings (again, in no particular order) are the following:

Broader impact. The COV finds that an appropriate mix of the two selection criteria, intellectual merit and broader impact, have been applied to proposal selection during the period under review. In most cases UARS continues to select proposals with the highest intellectual merit, using broader impact as a decisive factor in discriminating between proposals of equal merit. The panel found it difficult to judge the broader impact of some proposals and urges the UARS to extract further information on this aspect from successful proposers in their annual reports.

CISM legacy. The Center for Integrated Space weather Modeling is the largest and most visible grant in UARS. It is completely "new" money that is coming from the NSF-wide Science and Technology Centers program. It represents a ~10% temporary increment to UARS budget. It is in its 6th year of funding, with 4 more years of eligibility remaining. The COV considers it very important to clearly define the scientific legacy of CISM: what are the science and/or technology innovations that were accomplished by CISM that could not have been achieved without this major new funding. The COV also suggests that UARS should consider the consequences of a sudden ~10% funding drop when CISM ends. It is also suggested that UARS develop a strategy that may preserve the funding level.

Satellite data. There is a perception in the UARS community that UARS does not fund work that is primarily focused on analysis of satellite data. Although there are some proposals submitted and funded that use data from current and past satellite mission, the numbers are small compared to the proportion of published papers that analyze satellite data. Due to the evolving funding situation, the traditional support of satellite research by NASA has declined in recent years. This situation leaves a funding gap in this important area. We encourage UARS to clarify this question to the broader community.

Student pipeline. The COV noted that about 200 students participate in the annual CEDAR, GEM and SHINE meetings. In particular, the typical student attendance at CEDAR is ~100. A fraction of the student participants are undergraduates, but the majority are PhD students. The COV applauds the participation of undergraduates as it is very important for ensuring a healthy pipeline of domestic students in the space sciences. While it is clearly understood that not all space science PhD students will end up in academia or at research institutions, we are wondering if a somewhat smaller number of PhD students at these events would be desirable. The COV recommends that UARS conduct a survey of recent PhD-s to see if there is real problem with the student pipeline.

Facilities management. The nature of the Consortium of Resonance and Rayleigh Lidars (CRRL) and SuperDARN require strong cooperation among academic and research institutions and brings together scientific and technical expertise. This innovative concept could be utilized, if proven to be successful, as the model for similar consortia among groups of facilities. Facility consortia could improve scientific and technical productivity while reducing operational costs.

Facility lifecycle. It is clear that some of the UARS facilities are aging. In particular, some of the incoherent radars might have critical failures during the next decade that will necessitate either total replacement or major repairs. The COV recommends that UARS start a planning process for the upgrade, replacement or decommissioning of major facilities. As new facilities (hopefully) come online, the operational costs of all existing facilities might become too high for a balanced program. The COV urges the UARS staff to undertake a long-term planning of the facilities portfolio, including various options.

Data access and archiving. NSF-funded projects have returned a wealth of UARS data sets. The UARS has no stated policy for the archiving and distribution of these taxpayer-funded datasets and should adopt one consistent with NSF and GEO policies, and research community expectations (i.e. free and complete access to data sets and the tools to interpret them). In the absence of such a policy, the data sets may remain inaccessible to the research community, precluding harvest of their full value. Worse, they may be permanently lost upon the retirement or relocation of the PI. The NSF has a designated archive for ionosphere/thermosphere observations known as the CEDAR data center. However, this data center is password protected, does not contain the full range either of individual data sets or data sets acquired with NSF funding, and can be cumbersome to use. Statistics presented at this review indicate that this NSF-funded repository is under utilized.

The COV recommends commissioning of an advisory panel tasked with identifying

1. the most valuable (most requested) data sets acquired by NSF-funded activities,
2. data sets held in the community that are in danger of being lost,
3. suitable repositories (including home institutions linked as virtual observatories) capable of archiving and providing the data sets,
4. suitable technologies for distributing the data set in a manner that would facilitate correlative studies, and
5. the costs involved in transforming the data base into virtual data system easily accessible and usable by the vast majority of users.

SIGNATURE BLOCK:

For the NSF GEO ATM UARS COV
Tamas I. Gombosi
Chair

FY 2008 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

AERONOMY:

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The methods used include mail-in reviews and virtual panels. Both of these are appropriate and each has its own advantages. Mail-in reviewers are more likely to be experts in the particular discipline under review. However, the response rate is not very good. An advantage of panels is that they are able to assess the full range of proposals and to rank them against one another. To address the concern from the previous COV that the panel may tend to follow the lead of a single member, the current policy is to have two participants study each proposal in detail. Panels are now all conducted by telecom to save on expense and time. The program officers are continuing to monitor and adjust the balance between mail and panel reviews as needed. If, as discussed later, there is a shift to proposal deadlines rather than open solicitation, then this balance may need to be adjusted.	Yes
2. Are both merit review criteria addressed a) In individual reviews?	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

b) In panel summaries? c) In Program Officer review analyses? Comments: Yes, the evaluations in all categories do a comprehensive job of discussing both criteria.	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The reviews are usually detailed enough in giving reasons for their recommendations. The recommendation score and the reviewer's attention are more focused on the intellectual merit criterion. The content on broader implications is usually shorter. The balance can change depending on the nature of the proposal.	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel reports and summaries give a comprehensive report of the discussion. For most cases a consensus was reached.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: The documentation is excellent. It gives detailed summary of the rationale behind the decision.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: Yes. The PI is given the mail reviews and, if available, the summary of the panel report. These contain most of the information that is also available from the jacket. The program officer often provides a personal response (email or phone call) that is documented in the jacket.	yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The statistics indicate that the time exceeded the limit during this period. The percentages of decisions that were made in under 6 months were 39%, 29%, and 48% for the three years. For 2005 and 2006, the time to decision was greater than 9 months for slightly more than 30% of the proposals. The recent improvement indicates a concerted effort on the part of the program office to comply with the NSF guidelines.	Still needs improvement
8. Additional comments on the quality and effectiveness of the program's use of merit review process: The panel is concerned about the low response rate for mail reviews. This includes certain investigators who continue to receive AER awards but routinely decline all requests to participate in review activities.	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Overall, the program does a very effective job of having reviewers with appropriate expertise. This is clear from the thoroughness of the review summaries. As stated in an earlier question, the thoroughness of justification on the funding decisions is in general impressive.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The program does this to the best of its ability and there clearly appears to be adequate diversity in the reviewing from its statistics during the past reviewing period. Diversity in the reviewing process is clearly taken very seriously by the program.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Conflict of interest is a matter taken very seriously and is effectively resolved by the program. A number of examples clearly appear in the proposal review summaries.	Yes

4. Additional comments on reviewer selection:

[2] If "Not Applicable" please explain why in the "Comments" section.

Concerns that some well funded PIs do not effectively participate in the review process. This should be addressed.

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The mail-in and panel review processes combined with the efforts of the Program Director(s) have assured that the overall quality of the funded projects is high.	APPROPRIATE
2. Does the program portfolio promote the integration of research and education? Comments: Emphasis on student participation in funded programs strengthens education, but the increasing cost of graduate student support relative to the total award size is of concern. We note that the CEDAR meeting is a very good and effective way of exposing students to the field.	APPROPRIATE
3. Are awards appropriate in size and duration for the scope of the projects? Comments: Longer duration grants, where appropriate, should be encouraged. Grant sizes should reasonably reflect the amount of work proposed, which would likely dictate generally larger grants.	APPROPRIATE

[3] If "Not Appropriate" please explain why in the "Comments" section.

4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: It is difficult to identify innovative/transformative projects, but the overall program has vigour and excitement with a stream of new results, as for example evidenced in AGU presentations and the various activities at the annual CEDAR meeting. There is a close connection between science and new technology development. UARS funds both aspects. Further, the CubeSat program is a logical expansion of UARS especially considering the current development at NASA.	APPROPRIATE
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: Evolution across the field of Natural Science is going toward inter disciplinary research and aeronomy is no exception. Aerornomy, which already in itself is an inter-disciplinary science, has many researchers with involvements in multiple disciplines. We encourage this development.	APPROPRIATE

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: Most of the funded proposals have multiple investigators within the same institution. About 20% of the funded proposals are from multiple institutions. It is difficult to assess the annual funding levels without going into the individual jackets (statistics give totals requested, but not duration); the average annual grant size for 2007 is reported as $90k with a mean duration of 3.4 years. Overall, the program seems to have an appropriate distribution.	APPROPRIATE
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: For 2007 the program has 10 awards to new investigators (4 of these were CAREER awards) out of 48 awards total. In addition there are the FDSS appointments and also the CEDAR postdocs. On balance, the program appears to provide good support for new investigators.	APPROPRIATE
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The geographical distribution is as even as the field itself.	APPROPRIATE
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: Proposals and awards are clustered at a relatively small number of institutions that includes major research universities and private companies. The geographical distribution of these institutions is broad. There are also a few proposals each from many other institutions scattered around the US and in two territories. These include major research universities, other universities, universities serving under-represented minorities, 4-year colleges, and private companies. Funding success varies significantly among the institutions but some institutions in all categories receive awards.	APPROPRIATE

10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: The distribution of disciplines in funded grants is similar to that in proposals. There are several ways in which the disciplinary mix of the proposals differs from that in the community at large. For example, the use of satellite data, in particular work that is strongly dependent on satellite analysis, is poorly represented. The program office also notes that the proportion of proposals on laboratory chemistry and electrodynamics/sprite phenomena is in excess of their representation in the community.	APPROPRIATE
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: This is very difficult to assess because of insufficient information, but from the presentations by and discussions with program directors the program is keenly aware of the needs and appears to be pro-active. Some of the funding is going to minority serving universities.	APPROPRIATE
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The NSF Aerornomy Program provides national leadership in upper atmosphere research. The community, and with it the NSF Aeronomy Program, is keenly aware of the scientific issues associated with Climate change. As noted in the 2005 COV report, aeronomy research figures prominently in the NAS Decadal survey, and the NSF space Weather initiatives have intrinsic relevance to national priorities.	APPROPRIATE
13. Additional comments on the quality of the projects or the balance of the portfolio: The COV has concerns about the size of awards. Graduate student support in individual grants is an increasingly large fraction of a grant reducing senior salary support. Further, the COV have concerns about the apparent increase size of the community relative to overall AER funding. We also note that there is an increased proposal pressure arising from NASA's decreased level of funding in UARS science, a problem NSF UARS needs to address.	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

The managers in the program are clearly dedicated to effectively advancing the mission of UARS AER with a number of innovative new initiatives that appear to guarantee the future health and growth of the program. Methods of more effectively processing proposals have been instituted during the last COV review cycle. The COV is in general pleased with the management of the program.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

The program is astute in participation in advancing new initiatives such as the small satellite program, AMISR, FDSS, and others. An excellent example of education and outreach is the Ethiopia Space Weather workshop. The program has a number of talented new investigators supported through CAREER grants which indicates future health of the program.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The program needs to work on its future planning and prioritization and come up with solutions regarding several issues. These include 1) possibilities of imposing a deadline for core proposal submissions, 2) effectiveness of increasing the length of awards, 3) the issues of review panel versus write in proposal reviewing, 4) the continued growth and size of CEDAR, 5) funding the influx of a considerable number of new researchers into the system, and 6) how to achieve balance in funding the program due to unexpectedly rapid growth of several research areas (e.g. atmospheric chemistry and investigation of specialized electrodynamics phenomena).

4. Responsiveness of program to previous COV comments and recommendations.

Comments:

The program appears to have effectively addressed comments of the previous COV. Addressing these issues has provided an enhancement in the proposal reviewing process.

5. Additional comments on program management:

Due to the substantial increase in proposals in the program in recent years, it is necessary to consider more human resources. It appears, however, that the program is working to address this

issue to some degree but this must be more carefully evaluated. The difficulty in obtaining mail-in review requests is also a concern.

PART B. RESULTS OF NSF INVESTMENTS

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The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery: "</u>*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:
Discovery is the guiding principle for much of the work funded by the Aeronomy program. In this they continue to do an excellent job. Outcome of the goal of discovery takes various forms: publications in the scientific literature; presentations at conferences and workshops; data accumulated, processed and provided to other researchers; etc.

Highlights showing the quality and diversity of Aeronomy research are given in the AER highlights document.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."*

Comments:

In general the program does an outstanding job to promote the NSF wide goal of learning. There are a number of examples. One of the most prominent is the highly successful CEDAR program which trains large numbers of talented students and future researchers into the field. This program clearly creates an effective educational pipeline from the college to postdoctoral level. Another important educational component along these lines is the PARS summer school which trains graduate students in polar aeronomy and radio science. The FDSS program that AER supports provides opportunity for development of new faculty members in academia which train future scientists and engineers. Also the program has been successful in producing NSF Career award winners and therefore it promotes the success of talented new faculty researchers in the field. International workshops the program has been involved with trains a very diverse group of aspiring scientists and engineers across the world. An example is the IHY-Africa Space Weather Science and Education Workshop held in November 2007. Also AER has supported very innovative methods of education. An example is the Space Weather video on www.youtube.com which was developed through funding to the MIT Haystack observatory. In summary, the effectiveness of the AER program in achieving the NSF goal of learning is hard to fault.

Highlights showing the quality and diversity of Aeronomy research are given in the AER highlights document.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

Investment in larger instrumentation infra-structure is done through the UAF section of UARS and is covered under that part of the COV report. In addition, innovative new technology is continually being developed by individual investigators with support from AER.

Highlights showing the quality and diversity of Aeronomy research are given in the AER highlights document.

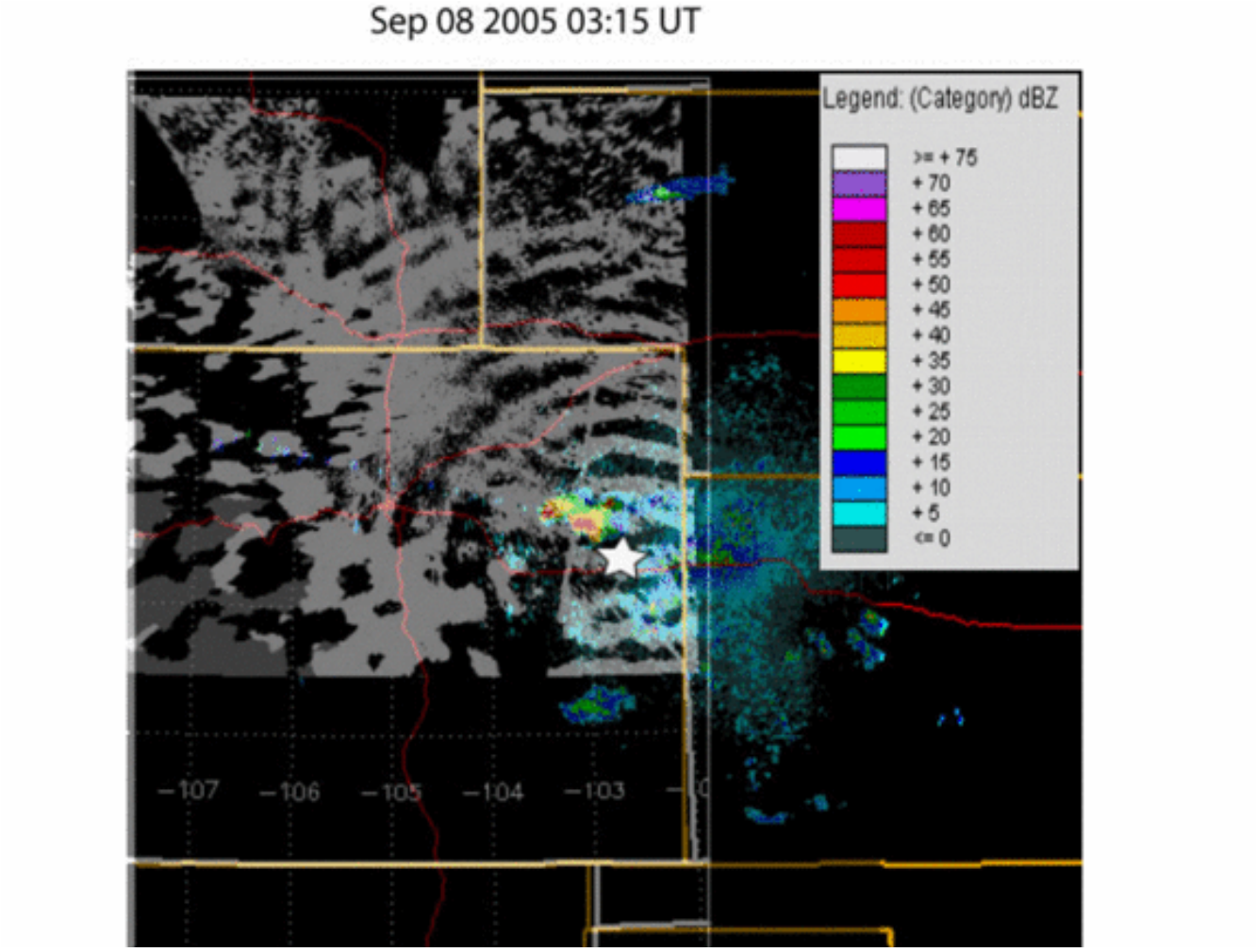
AER research highlights:

PDF file "1521 HighlightsAER.pdf" mailed separately.

NSF Highlights

Coupling of the lower and upper atmosphere

Highlight ID: 16592



Gravity waves observed in the upper atmosphere near 90 km over Colorado that were caused by a thunderstorm

Permission Granted
Credit: Steven Reising and Chiao-Yao She, Colorado State University

Atmospheric waves are prominent and ubiquitous features in the mesosphere and lower thermosphere, at altitudes of about 60 to 150 km. A particularly important feature of waves is that they carry energy and momentum from one region to another. The dynamics of the mesosphere and lower thermosphere, in fact, are largely controlled by waves.

Using an all-sky imager located at Yucca Ridge, Colorado and provided by Professor Yukihiro Nakamura of Kyoto University, researchers at Colorado State University observed a rare signature of a convectively-generated gravity wave at a height of 87 km. Professors Chiao-Yao She and Steven Reising, working with graduate student Jia Yue, correlated the images with a thunderstorm that occurred in the lower atmosphere, below 15 km altitude. Like ripples produced by a stone that strikes a pond, the gravity waves from the thunderstorm radiate outward from the source but they also propagate upward. Examination of observations over a period of time showed that these patterns can be observed only during the equinox periods of March/April or September/October when the horizontal east-west winds between 15 and 87 km are weak. The figure shows an observed gravity wave pattern (with the epicenter marked by a star) overlaid on a NEXRAD radar image of the associated thunderstorm in the troposphere separated by ~30 min, the time it takes the wave to propagate from 15 to 87 km altitude. These observations demonstrate the transient, direct coupling of energy from the troposphere to the mesosphere and lower thermosphere region, lasting on the order of several hours.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Graduate Education

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The effects of gravity waves on the atmosphere is currently one of the most active areas of research in atmospheric sciences. A key element of the effort is the question of what causes gravity waves. A second major factor is determining how they propagate or move through the atmosphere. This work clearly shows that lower atmosphere pheonomena, such as thunderstorms, are able to penetrate the upper atmosphere, where they can influence the winds, temperature, and composition of this region. It is advancing our knowledge of the generation, propagation, and influence of gravity waves on the atmosphere

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science BoardEnhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

The research results were made possible by an international collaboration with a Japanese scientist and included the participation of a graduate student in the analysis and interpretation.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware?*If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

Understanding the coupling between the lower and upper atmosphere is key to understanding the physics and physical processes related to climate change and space weather.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0545221
Award Title: Collaborative Research: A Consortium of Resonance and Rayleigh Lidars
PI Name: Steven Reising
Institution Name: Colorado State University
PE Code: 4202

0335127
Award Title: CEDAR Postdoc: Seasonal Variations in Mesopause Region Temperatures, Zonal and Meridional Winds: Climatology and Variability of Mean-State, Diurnal and Semidiurnal Tides
PI Name: Chiao-Yao She
Institution Name: Colorado State University
PE Code: 1521

NSF Contract Numbers:

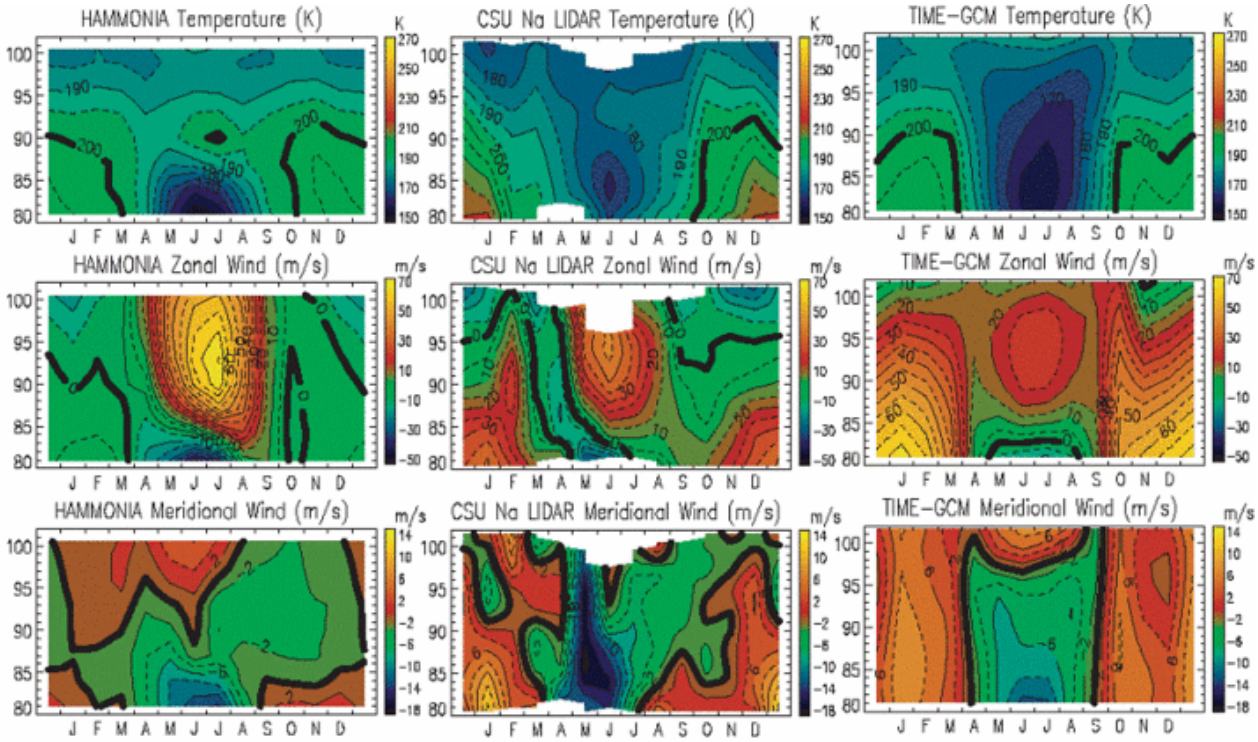
NSF Investments: None Applicable

Submitted on 02/28/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/06/2008 by William M. Smith

NSF Highlights

Middle Atmosphere Monthly Mean Temperatures and Winds

Highlight ID: 16633



The monthly mean temperatures and winds observed over Colorado derived from four years of observations. The middle row shows the observations, from 80 to 100 km, of the temperatures (top), the east-west winds (middle), and the north-south winds (bottom). The left and right panels show predictions from two theoretical models for the same conditions and location; the left column show simulations from the HAMMONIA model and the right column from the TIME-GCM. There are areas of good agreement between the data and models, but also areas of disagreement. Note that the two models do not always agree with each other.

Credit: Steven Reising and Chiao-Yao She, Colorado State University

Using a lidar, researchers at Colorado State University have assembled a unique dataset of winds and temperatures in the middle atmosphere. Observations have been obtained over four full years, with the observations covering the full 24-hour daily cycle of the winds and temperatures. Using these measurements, the team produced the first maps of the monthly means for the mesopause-region temperature and the horizontal winds in the east-west and north-south directions. The results provide an extensive reference climatology that will be useful in testing and developing theoretical models of the Earth's middle atmosphere.

These observations are particularly noteworthy since the Earth's middle atmosphere has long been one of the most challenging regions of the atmosphere to monitor and make observations. The altitudes are typically too high for weather balloons to study and too low for rockets and satellites to orbit. As a result, it has been difficult to establish even the "average" behavior of this region, such as what is the average temperature during June or how fast do the winds blow and do they change with the seasons?

Ground-based instruments have been used to monitor this region remotely, typically by using measurements of the nightglow, the natural emissions of the upper atmosphere constituents. Daytime observations were generally not possible since sunlight swamps the signal from the atmosphere. However, recent developments in lidar technology has enabled the making of measurements during both day and night, developments exploited by the Colorado State University researchers.

The figure shows a comparison between the lidar measurements, shown in the middle panel, and simulations from the models TIME-GCM (on the right) and HAMMONIA (on the left). Comparisons with the models of the upper atmosphere show general agreement, but there were also discrepancies between the observations and the model predictions, as well as differences among predictions from the different models which are being investigated by the researchers and the theoreticians.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This work has already advanced the frontiers of knowledge by delineating in detail the temperature and dynamics of the middle atmosphere over Colorado. Such

information is critically important for studies of the coupling between the lower and upper atmosphere, a topic of major interest and activity in the upper atmosphere research community. In order to carry out these observations, the researchers developed novel techniques, instruments, and analysis methods.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

The research team regularly includes graduate students and postdoctoral scholars in all facets of their research, from instrument development and adaptation to implementation, observation, and data analysis and interpretation.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

This project provides the necessary background conditions for studies of coupling between the lower atmosphere and upper atmosphere. Understanding the coupling is key to understanding the processes involved in climate change and space weather which affects communications and navigation systems.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0545221
Award Title: Collaborative Research: A Consortium of Resonance and Rayleigh Lidars
PI Name: Steven Reising

Institution Name: Colorado State University

PE Code: 4202

0335127
Award Title: CEDAR Postdoc: Seasonal Variations in Mesopause Region Temperatures, Zonal and Meridional Winds: Climatology and Variability of Mean-State, Diurnal and Semidiurnal Tides
PI Name: Chiao-Yao She

Institution Name: Colorado State University

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 02/28/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/06/2008 by William M. Smith

NSF Highlights

Sprites are brighter than Venus

Highlight ID: 16641

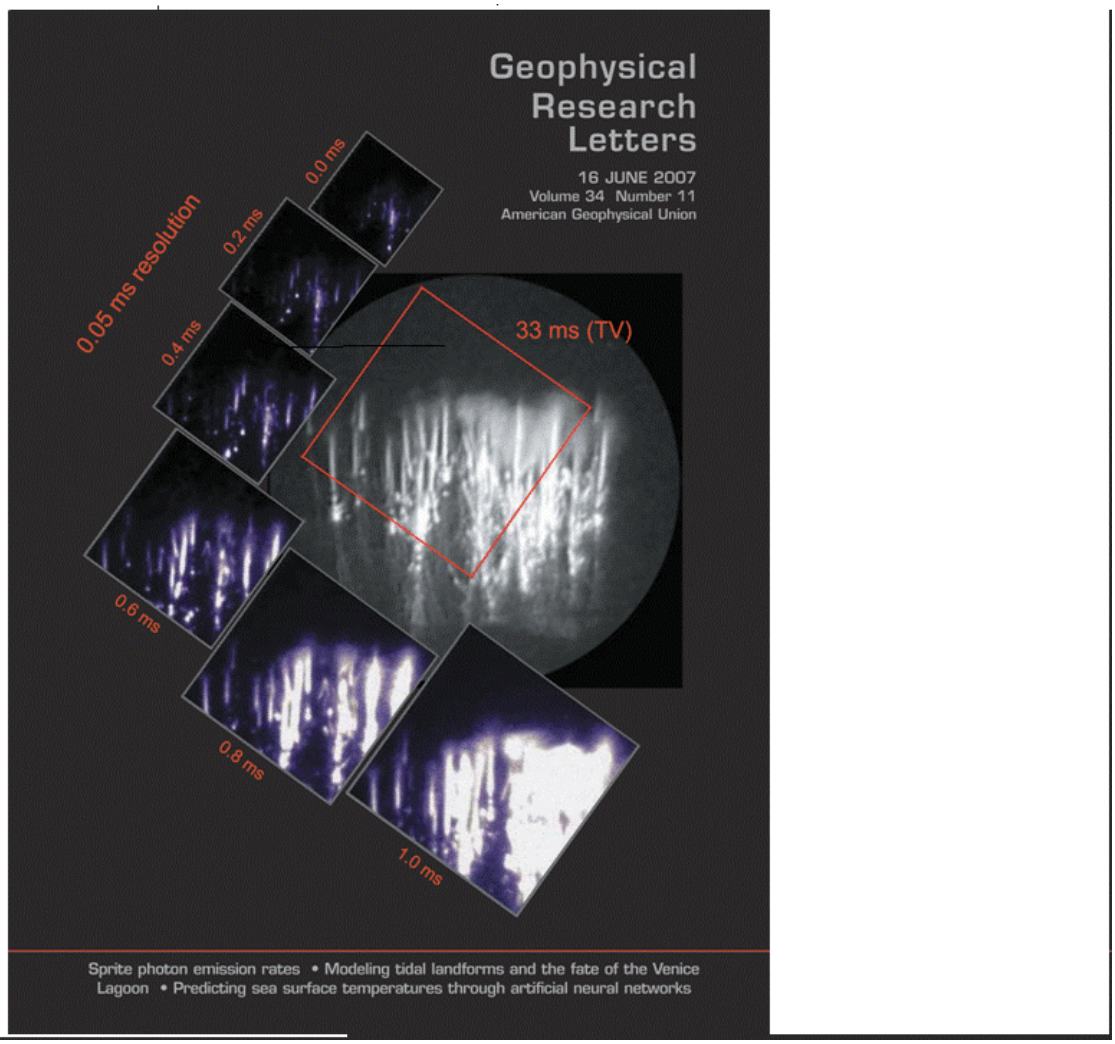
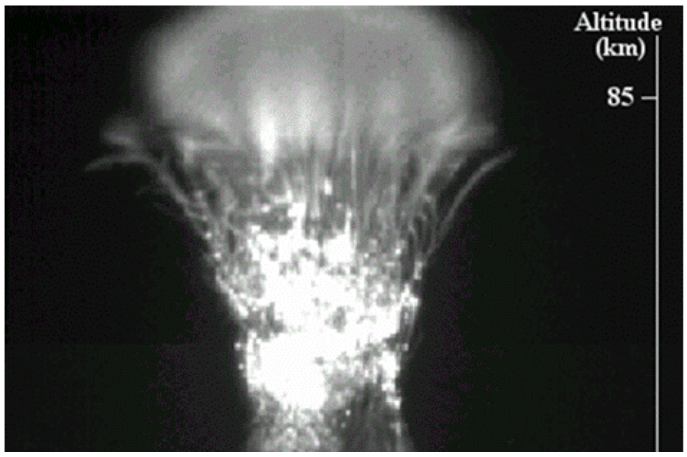


Figure 1. The cover of the journal Geophysical Research Letters with images of sprites taken by the research team; the figure illustrates the differences between images taken with the commonly used video resolution (33 ms) and images recorded at 10,000 fps (0.05 ms exposures).

Permission Granted

Credit: H. Stenbaek-Nielsen, U. Alaska-Fairbanks, and M.G. McHarg, US Air Force Academy



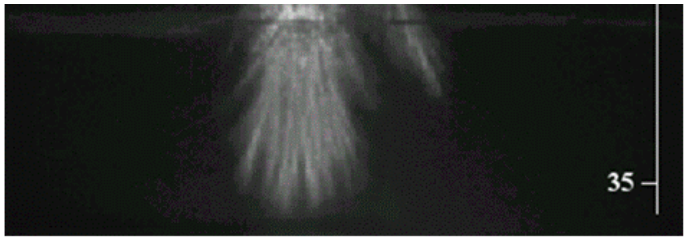


Figure 2. Large sprite. Note altitude scale for size. The long streamers seen in this 1 ms exposure are actually a smearing effect' from very fast bright streamer heads moving at up to half the speed of light.

Credit: H. C. Stenbaek-Nielsen, U. Alaska-Fairbanks, and M.G. McHarg, US Air Force Academy

Researchers at the University of Alaska and the US Air Force Academy have shown that sprites are very bright and might even be visible in daylight.

Sprites are large, but very brief (~50 ms), optical features observed in the mesosphere (30-100 km altitude) and are associated with lightning activity in the lower atmosphere.

H. C. Stenbaek-Nielsen and T. Kanmae from the University of Alaska at Fairbanks and M.G. McHarg of the US Air Force Academy analyzed images recorded at 10,000 frames per second. Two very surprising new findings emerged:

- streamers are usually seen in lower time resolution images as long streaks (see figure 1, panels to the left), but they are actually small, fast (~0.1 of the speed of light), and very bright, and initially move downward, then upward.

- the streamer "heads" in the images are equivalent to a star of magnitude -6, which is 5-10 times the brightness of Venus (Venus can be seen in full daylight)

The brightness of the streamers is so large that it seems to indicate the presence of intense processes that may affect the local atmospheric composition.

The image analysis was highlighted by Geophysical Research Letters and it was featured on National Geographic website, on BBC, and various other science news sources

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Graduate Education

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This project has advanced the frontiers of knowledge of sprites and transient luminous events that regularly occur during thunderstorm activity. These features were only discovered in 1989 and only recently have imaging techniques been developed that can amass significant quantities of information on the pheonomena. The extent to which sprites affect the chemistry, composition, and electrical field of the Earth is still unknown and represents an area of active interest for the atmospheric science community.

Does this highlight represent transformative research? *If so, please explain why.*
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Yes

The research involves collaboration between the University of Alaska - Fairbanks and the US Air Force Academy. Students are regular and active participants in all phases of the research. The results presented here constitute part of the thesis research project for a graduate student at the University of Alaska.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

No

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0535394
Award Title: Collaborative Research: CEDAR: Flickering and Auroral Roar
PI Name: Matthew McHarg
Institution Name: United States Air Force Academy
PE Code: 1521

0535476
Award Title: Collaborative Research: CEDAR: Flickering and Auroral Roar
PI Name: Hans Nielsen
Institution Name: University of Alaska Fairbanks Campus
PE Code: 1521

NSF Contract Numbers:

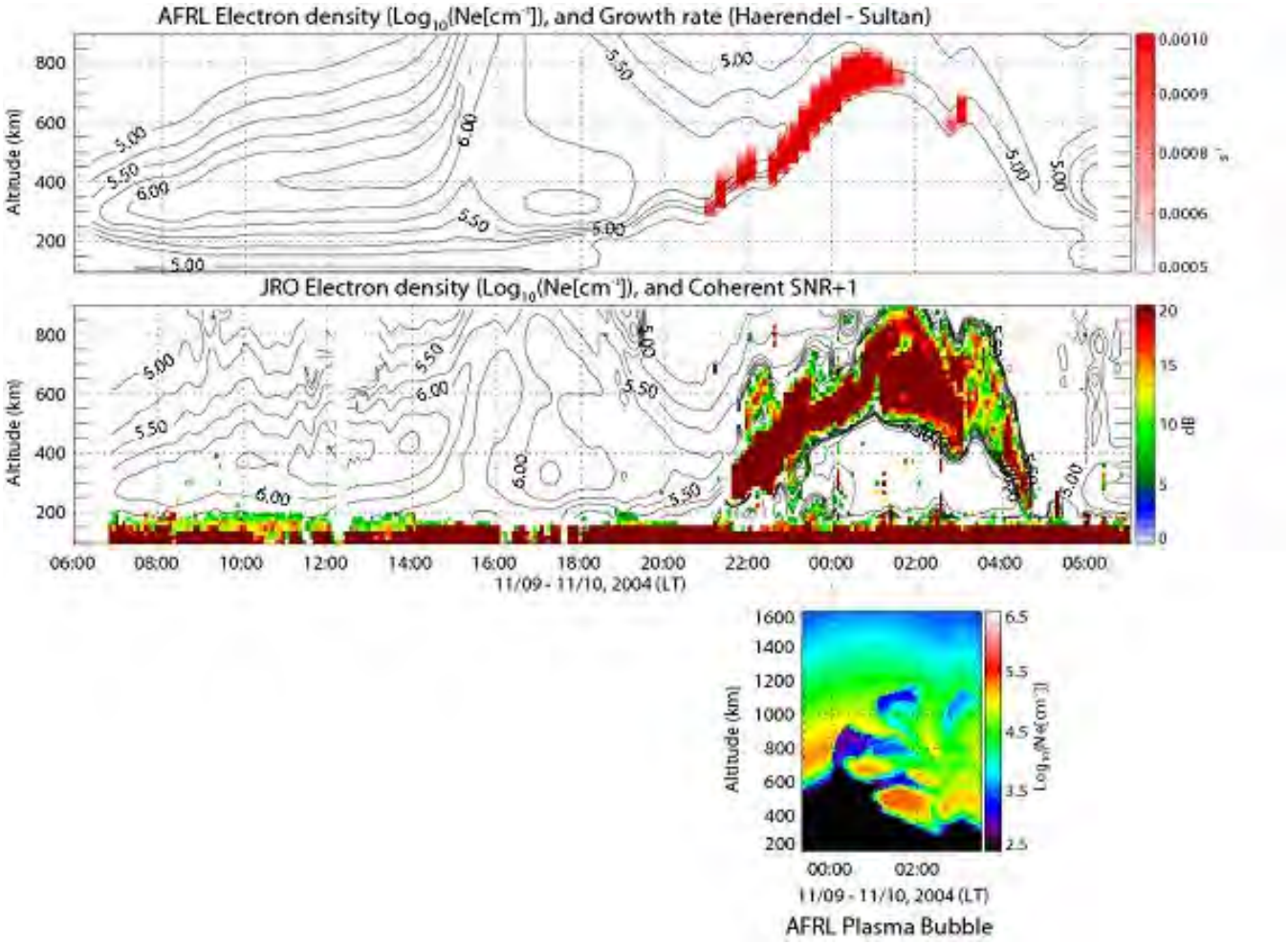
NSF Investments: None Applicable

Submitted on 02/28/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/06/2008 by William M. Smith

NSF Highlights

Prediction of Equatorial Electric Fields

Highlight ID: 16659



Measurements (middle panel) and predictions (upper panel) of the electron density and the development of turbulence at the magnetic equator. The red area in the upper panel shows the predicted growth rate for instabilities. The colors in the middle panel indicate the strength of the turbulence, with red indicating strong turbulence. The small color plot in the bottom panel shows detailed predictions from the model during the storm period. Note that the model predicts low density bubbles extending to altitudes greater than 1000 km during the storm.

Permission Granted
Credit: Michael Kelley

One of the major challenges of the National Space Weather Program in the United States is to predict the generation of intense turbulence in the equatorial and low latitude ionosphere. This is referred to as a Convective Equatorial Ionospheric Storm since, much like a thunderstorm, low density material erupts upward, releasing stored gravitational energy. This is an important phenomenon since both communication and navigational systems can be severely affected by the associated turbulence. Professor Michael Kelley and collaborator James Retterer of the Air Force Research Laboratory used solar wind data obtained upstream of the Earth to predict the electric field at Jicarmarca Radio Observatory, an NSF facility in Peru. This was input into the Air Force's physics-based assimilative model, which successfully predicted an event observed during a strong magnetic storm in November 2004.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Major Multi-User Facilities (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:

The equatorial electric field is one of the key processes that determine the structure and behavior of the ionospheric plasma. The ability to predict the field represents is important in predicting the behavior of the equatorial ionosphere.

Does this highlight represent transformative research? *If so, please explain why.*
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No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware?*If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

The equatorial ionosphere has structure and dynamics that produce scintillation of radiowave signals. Navigation and communication systems are affected by these scintillations. This research will lead to better models that space weather forecasters can use to provide improved alerts and warnings to operators of these technical systems.

GEO/OCE 2008

Program Officer: Robert Robinson

NSF Award Numbers:

0551107

Award Title:	Wind and Wave Patterns in the Earth's Ionosphere
PI Name:	Michael Kelley
Institution Name:	Cornell University
PE Code:	1521

NSF Contract Numbers:

NSF Investments: None Applicable

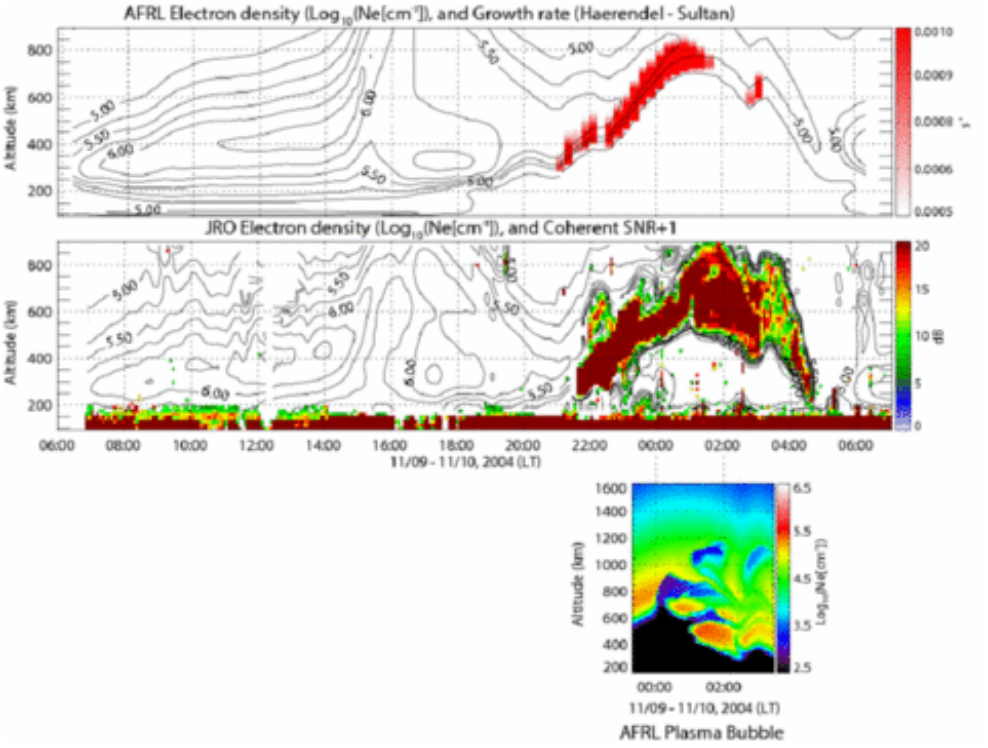
Submitted on 03/03/2008 by Robert M. Robinson

NSF Highlights

Predicting Space Weather

Highlight ID: 16718

One of the major challenges of the National Space Weather Program in the United States is to predict the generation of intense turbulence in the equatorial and low latitude ionosphere. One type of these turbulent events has been termed a Convective Equatorial Ionospheric Storm since, much like a thunderstorm, low density media erupt upward, releasing stored gravitational energy. This is an important phenomenon since both communication and navigational systems can be severely affected by the associated turbulence. Professor Michael Kelley and collaborator James Retterer of the Air Force Research Laboratory used solar wind data obtained upstream of the Earth to predict the electric field at Jicamarca Radio Observatory, an NSF facility in Peru. This was input into the Air Force's physics-based assimilative model, which successfully predicted an event observed during a strong magnetic storm in November 2004.



Measurements (middle panel) and predictions (upper panel) of the electron density and the development of turbulence at the magnetic equator. The red area in the upper panel shows the predicted growth rate for instabilities. The colors in the middle panel indicate the strength of the turbulence, with red indicating strong turbulence. The small color plot in the bottom panel shows detailed predictions from the model during the storm period. Note that the model predicts low density bubbles extending to altitudes greater than 1000 km during the storm.

Credit: Michael Kelley, Cornell University

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Public Understanding of Science

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This project makes a major contribution towards the goal of predicting and forecasting space weather events by achieving the first prediction of an equatorial space weather event based on knowledge of existing conditions in near-Earth space. Space weather prediction and forecasting is a national priority because of the major effect it has on communication and navigation devices.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

This research is transformational since it achieved the prediction of a space weather event, one of the long-standing goals of the National Space Weather Program, and one with significant impact for communications, navigation, and radar systems. The successful execution of the modeling and event prediction provides a good benchmark for the ongoing efforts in this area.

Does this highlight represent Broadening Participation? *If so, please explain why.*
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No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

In April, NASA will launch a satellite named the Communications and Navigation Outage Forecast System (C/NOFS), which has a goal of observing and predicting space weather events and the disruptions they cause in trans-ionospheric signal propagation. This project showed that

the satellite observations may be able to be used to predict both the suppression and generation of space weather events, a major step in proving that the system will work and work well.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0551107
Award Title: Wind and Wave Patterns in the Earth's Ionosphere

PI Name: Michael Kelley

Institution Name: Cornell University

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/05/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/05/2008 by Melissa J. Lane

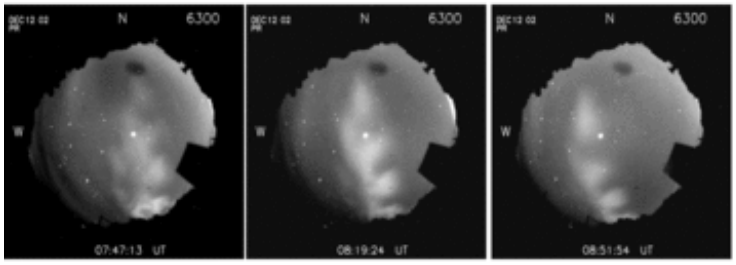
NSF Highlights

Discovery of new airglow features over Arecibo Observatory

Highlight ID: 16779

A new type of phenomenon has been found by Boston University researchers making all-sky optical observations at the Arecibo Observatory (18.3^{O} N, 66.7^{O} W). Typical optical signatures from the upper atmosphere are *dark* bands in 630.0 nm airglow; these are associated with midlatitude instabilities. Less frequently, *dark* airglow depletions are observed, and these are related to irregularities in the plasma structure. The figure shows the discovery images of***very bright*** and structured regions embedded in the ambient and darker background, the opposite of all previous airglow structures seen at Arecibo. These features have been observed only during December solstice months and only during geomagnetically quiet conditions. Ongoing analyses and modeling are underway to see if these phenomena are related to density enhancements or dynamic processes such as the refilling of flux tubes or motions of the ionospheric layers.

Airglow Brightening at Arecibo, 12 December 2002



First observations of bright airglow features over Arecibo Observatory in Puerto Rico. These observations were made on December 12, 2002, and show the changes and motion of the features over about an hour.

Permission Granted
Credit: Carlos Martinis and Michael Mendillo, Boston U.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Instrumentation

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The low latitude ionosphere exhibits sudden and dramatic changes in structure, dynamics, and densities which have a tremendous effect on space weather. The development and evolution of these perturbations are captured by a variety of instruments, one of which is the imager involved in this research. Obervations of features such as those detected for the first time in this study will be an important test of the capabilities of space weather models currently under development.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

These figures represent the first detection of such features in the low latitude ionosphere. The fact that they seem to be confined to a particular month (December) and occur only during geomagnetically quiet conditions remains to be explained by theory and models; currently, there is no explanation for these features.

Does this highlight represent Broadening Participation? *If so, please explain why.*
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No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

Space weather effects can be particularly large and impulsive at low latitudes. The occurrence of features such as these represents a significant constraint and a rigorous test of space weather models, which are a national priority due to the significant influence of space weather on satellites, communications, navigations, and power systems.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0623854

Award Title:	Imaging Science and Modeling Investigations of the Upper Atmosphere
PI Name:	Michael Mendillo
Institution Name:	Trustees of Boston University
PE Code:	1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/09/2008 by Cassandra Fesen

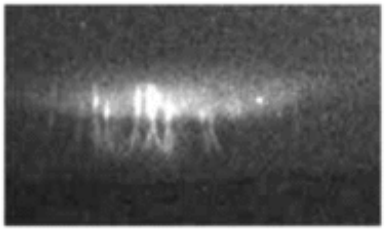
NSF Highlights

Rare Negative Sprite Measurements over South America

Highlight ID: 16780

Sprites are part of a family of Transient Luminous Events which include elves, halos, and jets. Sprites occur in the middle atmosphere over severe thunderstorms and appear as clusters of tall bright columns with complex streamers. Sprites are a global phenomenon, and have been overwhelmingly associated with large positive cloud to ground (CG) lightning strikes (although there have have been two confirmed exceptions to this rule to date). During a collaborative campaign in Southern Brazil, over 440 Transient Luminous Events were observed over a large mesoscale storm, several of which were clearly associated with **negative** cloud to ground discharges. Coincident VLF/ELF measurements have confirmed their negative polarity. Simultaneous low light image data have provided the clearest measurements to date of the morphology and vertical extent of negative sprites. One of these rare events is displayed in the figures below.

1.



2.

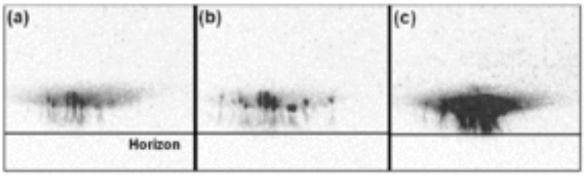


Figure 1. Enlarged (6° x 4°) image of a negative sprite observed at 05:29:33.522 UT., showing a well developed halo (centered at 83 km) and streamers extending down to 63 km

Figure 2. Enlarged images (a, b) showing the downward development of the negative event over two consecutive video fields (duration 33 ms). The data have been enhanced to show the sprite structures. For comparison, (image c) shows a positive sprite-halo of similar charge moment, which occurred at approximately the same location one hour hour earlier.

Permission Granted
Credit: Michale Taylor, Utah State University

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This project is advancing the frontiers of knowledge of sprites and transient luminous events that regularly occur during thunderstorm activity. These features were only discovered in 1989, but they are so short-lived and sporadic that imaging techniques are severely challenged to obtain observations. and only recently have imaging techniques been developed that can amass significant quantities of information on the pheonomena. The extent to which sprites affect the chemistry, composition, and electrical field of the Earth is still unknown and represents an area of active interest for the atmospheric science community.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

These images confirmed the existence of negative sprites, sprites that occur during negative cloud-to-ground lightning discharges. Apparently, negative sprites are very rare and will represent a significant challenge to the theoretical understanding of sprites and a severe test of numerical models that aim to predict and explain the occurrence of sprites.

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

No

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0355190
Award Title: In-situ Electrodynamics over Sprite Producing Storms in Southern Brazil

PI Name: Robert Holzworth

Institution Name: University of Washington

PE Code: 1521

0221968
Award Title: Novel Remote Measurements and Analysis of Continuing Lightning Current

PI Name: Steven Cummer

Institution Name: Duke University

PE Code: 1525

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/09/2008 by Cassandra Fesen

NSF Highlights

Space Weather Educational Video on YouTube

Highlight ID: 16781

MIT Haystack Observatory has announced its first educational You Tube video: Space Weather FX. The video can be seen at http://www.youtube.com/watch?v=fZ-L-pS0syc entered under the category of "Science & Technology", with additional "tags" including space weather, Earth, sun, and GPS. This is the first program in what will be a 9 episode series. It is available in several forms for convenient computer viewing, including Quicktime, Flash, MPEG, and Windows Media Player (WMV) formats. The video podcast will also be available through iTunes, where users can subscribe to the series for download and easy viewing on iPods and compatible devices. The series' home website is at http://www.h http://www.haystack.mit.edu/swfx

Space Weather FX was created by a team of producers in Massachusetts, with help and inspiration from the MIT Haystack Observatory Atmospheric Sciences Group, the National Science Foundation's Geosciences directorate (Upper Atmospheric Facilities division), NASA, and many other institutions.

Primary Strategic Outcome Goal:

- Public Understanding of Science

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This video provides educational material to the general public in a highly visible and popular forum, YouTube. The content is a mix of scientific, technical, and expository material with recent research findings. It aims to contribute to raising public awareness and understanding of Space Weather and its consequences.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

The YouTube video can be viewed by anyone, in any country, at any time. It provides educational material to the general public in a highly visible and popular forum.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

The project contributes to efforts to increase scientific and technical literacy and competency. It aims to educate the general public and could conceivably spark interest in some viewers tolearn more about space science or science in general.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0455831
Award Title: Studies of the Plasmasphere Boundary Layer with Distributed Arrays of Radio Instruments

PI Name: Anthea Coster

Institution Name: Massachusetts Institute of Technology

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

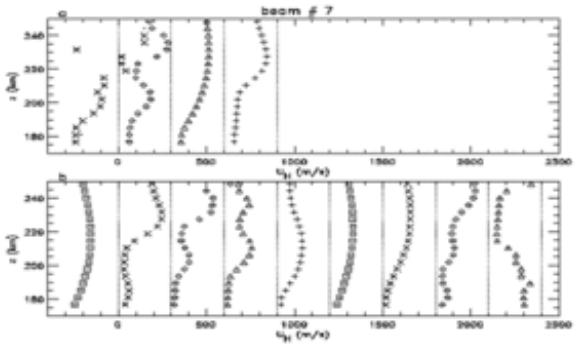
Submitted on 03/09/2008 by Cassandra Fesen

NSF Highlights

Improved time resolution of neutral wind measurements using the Poker Flat radar

Highlight ID: 16784

A novel method has been developed to infer the background neutral winds with higher time resolution from the Poker Flat Incoherent Scatter Radar in the region from about 170 to 250 km. The technique involves analyzing the Poker Flat radar observations of individually propagating gravity waves using a sophisticated numerical relation among the waves' parameters. The method enables the extraction of neutral winds every 10 minutes in the thermosphere, allowing for an enhanced knowledge of the evolution of the neutral thermospheric winds in time. This application is providing a much better understanding of the neutral dynamics and large-scale waves that propagate through the thermosphere. An example is shown in the figure. Wave signatures are clearly evident in the extracted winds, with vertical wavelengths of about 40-60 km. We can also see a mean background wind of 200 m/s in the NW direction at an altitude of about 180 km. This background wind decreases to 100 m/s in the NW direction at about 220 km, and again remains fairly constant over the four hour time period.



Measurements of neutral winds by the Poker Flat incoherent scatter radar on December 13, 2006, extending from 170 to 250 km. The top panel shows measurements over 30 minutes, from 21.0 to 21.5 UT, and the bottom panel over 90 minutes, from 22.0 to 23.5 UT.

Permission Granted
Credit: Sharon Vadas, CoRA

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The inference of neutral winds in the upper thermosphere has generally required averaging measurements over periods of an hour or so to achieve satisfactory results. As a result, there has been little information on thermospheric winds on short time scales and consequently a limited ability to test models and predictions of thermospheric behavior on time scales less than an hour.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

This research has resulted in a new methodology to apply to observations made by the Poker Flat radar, which enables significant enhancements to the information extracted from the measurements. Analysis of some of the observations indicated that gravity waves dissipating in the thermosphere were contributing to the generation of neutral winds on times scales of about 30 minutes, a new result.

Does this highlight represent Broadening Participation? *If so, please explain why.*
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Yes

This research supports the work of a female P.I. and a young researcher at the beginning of his professional career.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

The research will significantly add to the amount of information able to be inferred from the Poker Flat radar and contribute to studies of space weather, plasma physics, and gravity waves.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0537311
Award Title: Thermospheric Responses to Gravity Waves Dissipated by Molecular Viscosity and Thermal Conductivity
PI Name: Sharon Vadas

Institution Name: NorthWest Research Associates, Incorporated

PE Code: 1521

0719808
Award Title: Collaborative Research: NSWP--Investigation of Global E-region Conductivities Relevant to the Seeding and Variability of Equatorial Spread F Using Measurements from COSMIC
PI Name: Michael Nicolls

Institution Name: SRI International

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/09/2008 by Cassandra Fesen

NSF Highlights

Long Term High Altitude Hydrogen Observations

Highlight ID: 16787

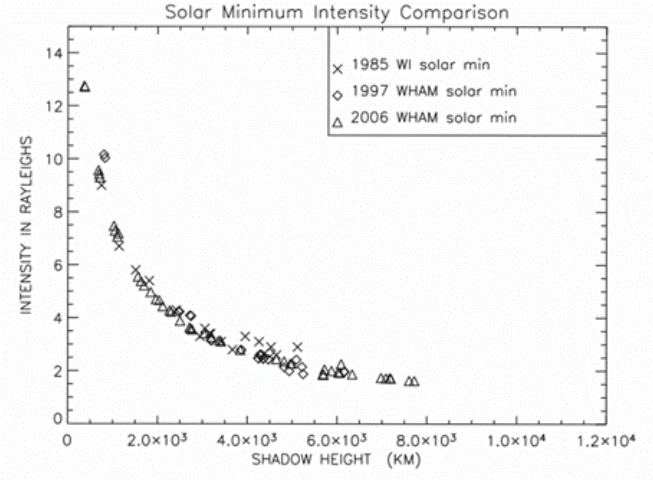

Figure 1.

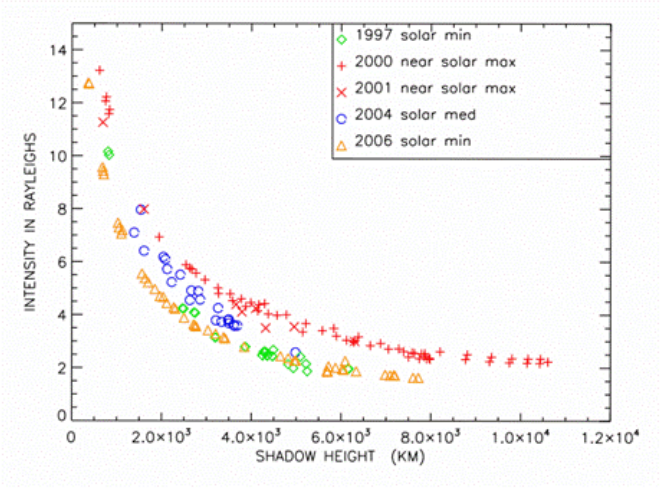

Figure 2.

Figure 1. Observations of the brightness of hydrogen emissions in the upper atmosphere during three different solar minimum periods as a function of height. The measurements are in very good agreement.

Figure 2. The variation of the observed brightness as a function of solar cycle. Larger intensities are observed during solar maximum periods.

Credit: Susan Nossal, U. Wisconsin

The University of Wisconsin Aeronomy group has completed analysis of recent Fabry-Perot observations of upper atmospheric hydrogen during solar minimum conditions, establishing a baseline data set of three solar cycles (Fig. 1). These data agree to within 10% uncertainties, and establish a reference data set of highly precise, consistently calibrated, hydrogen emission observations that can be used to compare with observations far into the future. The Intergovernmental Panel on Climate Change has emphasized the importance of long-term data sets to understanding the Earth's climate. Knowledge of the upper atmosphere and coupling processes between regions is becoming increasingly recognized as important for the understanding of the climate system as a whole. One of the potential diagnostics of global change in the upper atmosphere is exospheric hydrogen that is predicted to increase in response to rising concentrations of methane, a primary greenhouse gas.

The reproducibility of the solar minimum hydrogen observations also confirms evidence for a mid-latitude solar cycle variation with higher intensities observed during solar maximum conditions (Fig. 2). The solar cycle is a dominant source of natural variability in the upper atmosphere and must be accounted for when isolating potential signs of long-term change in the region.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This research focuses on detailed understanding of the planets upper atmosphere over a long time period by obtaining and analyzing observations of hydrogen at high altitudes. Theoretical models have indicated that small changes occurring in the lower atmosphere due to climate change are likely to generate large changes in the upper atmosphere that are more easily detectable.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

This research supports the creation and maintenance of a long term upper atmosphere database. Such databases are crucial in efforts to quantify and elucidate possible effects of climate change and the occurrence of global warming.

Does this highlight represent Broadening Participation? *If so, please explain why.*
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organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

A female PI is involved in the research.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below. It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.*

Yes

These measurements provide a very long baseline of observations that are necessary in order to discern and understand climate change and global warming and their consequences.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0535433

Award Title: CEDAR: Physics of the Hydrogen Geocorona

PI Name: Fred Roesler

Institution Name: University of Wisconsin-Madison

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

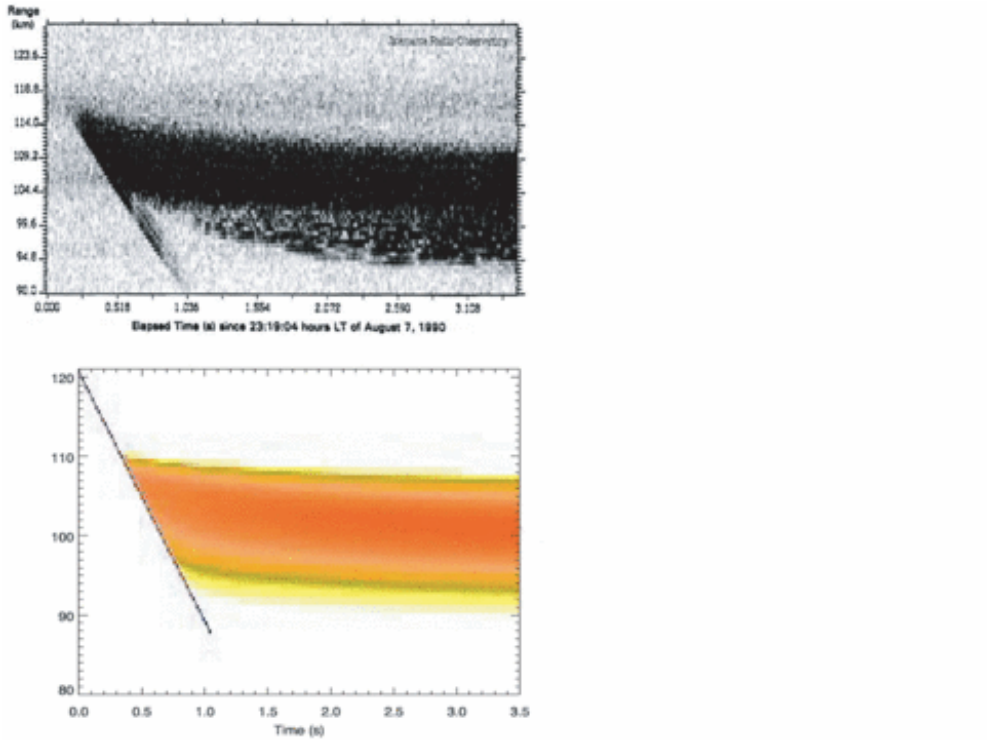
Entered on 03/09/2008 by Cassandra Fesen

NSF Highlights

Simulations of upper atmosphere meteor trails

Highlight ID: 16789

Every day, the Earth's upper atmosphere is bombarded by small meteors. Recent estimates for the amount of this material entering the atmosphere is 44 tons, and observing systems regularly record images of the trails as the meteors pass through the atmosphere. A theoretical model has recently been developed to simulate observations of meteor trails obtained by high power radars. The model results indicate that nearly all of the billions of daily meteor trails produced in the upper atmosphere become turbulent. By simulating the different characteristics of these complex, radar reflective, plasma trails it is possible to infer several properties of the meteoroid and surrounding atmosphere, such as the meteoroid composition. Improved understating of the meteor flux is useful for researchers in manned and unmanned space flight, upper atmospheric science, and solar system evolution.



Observation (top) and simulation (bottom) of the radar detection of a micro-meteoroid produced trail over Jicamarca, Peru. This simulated radar image is based on a meteor traveling 55 km/s, with 0.1 mg mass, and a magnesium composition.

Permission Granted
Credit: Lars Dyrud, CRS

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The passage of meteors through the Earths atmosphere is an extremely complex process, accompanied by the generation of ionized particles, turbulence, and chemical and dynamical processes. Theoretical understanding of these processes is a significant challenge, but one that contributes to the knowledge base of several fields, such as astronomy, space science, and chemistry. This particular project involves detailed modeling of the plasma surrounding the meteor in its motion through the atmosphere.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

The successful simulation of the meteor observation is a significant step towards better understanding of the physical processes associated with meteor dissipation in the atmosphere, while suggesting that nearly all meteor trails will become turbulent.

Does this highlight represent Broadening Participation? *If so, please explain why.*
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Yes

The PI is a young researcher who regularly involves students and postdoctoral scholars in his research.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

Detailed modeling of meteor trails in the atmosphere involves knowledge of meteor composition, fluxes, and velocities, all of which are relevant in the design and engineering of space vehicles. There are potential benefits to plasma physics as well.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0613706
Award Title: Collaborative Research: Meteor Plasmas - Dynamics and Radiowave Scattering
PI Name: Lars Dyrud

Institution Name: Center For Remote Sensing Inc

PE Code: 1521

0638912
Award Title: Collaborative Research: A New 50 MHz Radar for Meteor and Aeronomical Science
PI Name: Lars Dyrud

Institution Name: Center For Remote Sensing Inc

PE Code: 1521

0636473
Award Title: Comprehensive Plasma Line Studies at Arecibo Observatory

PI Name: Lars Dyrud

Institution Name: Center For Remote Sensing Inc

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/09/2008 by Cassandra Fesen

NSF Highlights

Depletion of Electron Densities by a Large Rocket Burn

Highlight ID: 16791

The first use of an *all-sky imager* to record the severe ionospheric perturbations caused by the launch of a large rocket was made possible by Boston University's optical facility on the grounds of the Haystack Observatory in Westford, MA. Not all rockets keep their engines burning as they follow their trajectories into the Earth's upper atmosphere, but when they do the exhaust gases cause an extremely rapid recombination of the oxygen ions and electrons that are in the Earth's ionosphere. The neutral atoms that result from this recombination are often left in excited states and emit photons at a wavelength of 6300 A, the famous *red line* of the aurora. The red line emission observed during a Titan rocket launch on April 30, 2005, is shown in figure 1.

The spatial and temporal pattern of this red glow maps the regions where the enhanced loss of electrons takes place --- and thus where deep depletions of the ionosphere's total electron content occur. The depletions occurring during the Titan rocket launch were observed by a network of GPS receivers in North American. Figure 2a shows a time during the burn (00:56-00:58 Universal Time, on 30 April 2005). The initial total electron content (TEC) depletion, of about 30%, can be observed as a light blue line. Figure 2b shows a time period 30 minutes after the burn. This shows that the total electron content has decreased by about half, as indicated by the region shown in dark blue. Such perturbations in total electron content can cause errors in the use of GPS systems for precise navigation.

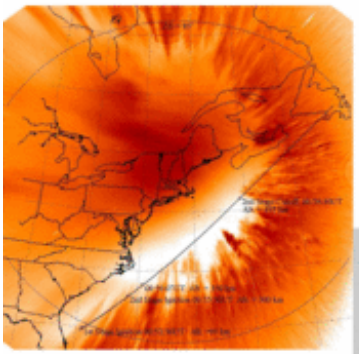

Figure 1. Observations of the airglow during the rocket burn.

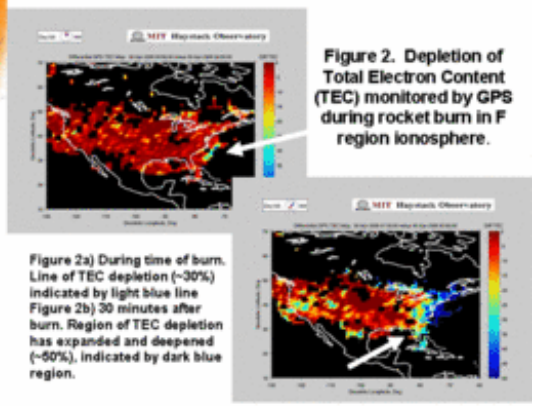

Figure 2. Depletion of Total Electron Content (TEC) monitored by GPS during rocket burn in F region ionosphere.

Figure 2a) During time of burn. Line of TEC depletion (~30%) indicated by light blue line Figure 2b) 30 minutes after burn. Region of TEC depletion has expanded and deepened (~50%), indicated by dark blue region.

Figure 1. Red line emission observed during the launch of a Titan rocket in April 2005.

Figure 2. Depletion of the total electron content in the Earth's ionosphere during the rocket launch.

Credit: Michael Mendillo, BU, and Anthea Coster, MIT

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Instrumentation

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This project focuses on understanding perturbations to the Earths upper atmosphere and ionosphere, a region of great interest and importance since it can exhibit large effects due to space weather, as illustrated by the figures attached. The rocket launch presented an excellent opportunity to obtain information on such perturbations, since the conditions before and during the launch could be characterized and the composition of the rocket exhaust is known.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
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Yes

This project includes the participation of a female PI and a member of an under-represented group. Graduate students regularly participate in the two projects research.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

GPS technology has many uses in todays society, both military and civilian, including aviation, farming, navigation, emergency response, mapping, and construction. The GPS system is subject to large errors during space weather events such as the one investigated in this project, and efforts to understand and account for these effects is an extremely active area of research with very broad impact.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0455831
Award Title: Studies of the Plasmasphere Boundary Layer with Distributed Arrays of Radio Instruments

PI Name: Anthea Coster

Institution Name: Massachusetts Institute of Technology

PE Code: 1521

0623854
Award Title: Imaging Science and Modeling Investigations of the Upper Atmosphere
PI Name: Michael Mendillo

Institution Name: Trustees of Boston University

PE Code: 1521

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/10/2008 by Cassandra Fesen

FY 2008 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV: 7/22/08-7/25/08
Program/Cluster/Section: **Magnetospheric**
Division **ATM**
Directorate: GEO
Number of actions reviewed: **Awards: 15** **Declinations: 8** **Other: 0**
Total number of actions within Program/Cluster/Division during period under review: **Awards: 91** **Declinations: 164** **Other: 25**
Manner in which reviewed actions were selected: **Three selected that were primarily non-science dealing with outreach or policy that caught the COVs interest.** **Ten provided by the program manager because they represented difficult decisions, examples of resourceful collaborations to provide funding, and examples of support for high-risk projects.** **Ten were selected because they were near the border between funded or declined, or seemed anomalous in some way.**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The program director employs both mail-in and virtual panel reviews effectively. At least 3 reviews were required for base grant proposals. The program director went on a site visit to Gekelman's plasma laboratory and to a meeting at the University of Michigan to discuss the NASA-NSF Space Weather Partnership.	YES
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: The reviewers tend to focus on intellectual merit. However, program officer review analyses clearly call out both criteria. The NSF has been the only agency in the United States with a mandate to distribute funding based primarily on scientific merit. While the Broader Impacts are important, the	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

Magnetospheric COV is distressed by the perceived shift away from scientific merit and increased importance placed on the Broader Impacts.	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: With very few exceptions, the reviews were detailed and thoughtful. The similar comments seen in many reviews are a good indicator that the proposals were carefully reviewed.	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The panel summaries generally reached consensus, provide sufficient detail on the varying viewpoints expressed, and summarize the reasons for the recommendation.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: The documentation is extremely detailed and very compelling, exhibiting a good understanding of the issues involved.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: The program officer provides thoughtful letters summarizing the reasoning behind the decision, including the original documents upon which this decision is based. The letters are generally very gentle and offer suggestions for future efforts.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The COV panel congratulates the magnetospheric program on regularly meeting the NSF's 6 month submission to decision timeline.	Yes.

8. Additional comments on the quality and effectiveness of the program's use of merit review process:

The program officer used good judgment on occasion in providing a moderate level of seed funding for lowly rated proposals from young scientists and innovative but high risk proposals from more senior scientists.

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Virtual panel reviews have enabled the program officer to elicit the assistance of leading scientists in proposal review and reduced both expenses and the carbon footprint of reviews.	Yes.
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Because only a few reviewers fill out this information, the results may be skewed. Nevertheless the ratios of male to female and minority to non-minority reviewers appear consistent with those for the discipline as a whole. Most	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

reviewers come from PhD and research intensive PhD institutions, with the balance coming from other sources. The program officer is to be congratulated for achieving a geographic distribution of reviewers that is more diverse than that for proposers and enlisting the support of numerous foreign reviewers.	
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Individual reviewers are asked to self-identify potential conflicts of interest and judge how serious the degree of conflict is. On at least one occasion, the program officer provided prompt action to remove both a reviewer from the discussion and the review from consideration. j	Yes

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: By looking solely at the titles of the proposals it is difficult to discern the quality of the research being undertaken. Anecdotal evidence indicates that the program is generating important results. For example, the program has supported research into fundamental problems such as polar cap potential saturation, measuring the mass density of the magnetosphere using ground-based magnetometer arrays, and the microscopic details of magnetic reconnection. In addition, the program has made a strong and invaluable investment in obtaining data from arrays of ground magnetometers throughout the Americas. The NSF-supported GEM program is rightly regarded as the centerpiece of magnetospheric research in the United States (and abroad), attracting both senior scientists and students for in depth discussions of topical research problems. More extensive information on outcomes and results (papers published, citations, discoveries) is needed to fully assess the quality of the research program. The program has had an important impact on education in our research area by funding CAREER proposals at U. Iowa, Dartmouth, U Delaware, and UT	

[3] If "Not Appropriate" please explain why in the "Comments" section.

Arlington, Florida Institute of Technology, and Embry-Riddle as well as FDSSP proposals at NJIT, George Mason, and Dartmouth.	
2. Does the program portfolio promote the integration of research and education? Comments: Most funded proposals involve graduate and undergraduate education. This criterion was used in funding decisions when proposals of equal merit were received.	Yes.
3. Are awards appropriate in size and duration for the scope of the projects? Comments: The COV viewed with alarm the decrease in the mean and median durations and amounts of new grants over the past three years. Grants of $90K lasting 3 years do not go very far in the present circumstances, particularly when they are supporting researchers on soft money.	No.
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: The program officer has been pro-active and used good judgment in funding some projects with high potential but also high risks.	Yes
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The program officer has entered into partnerships with other agencies that fund projects involving fundamental and laboratory plasma physics and information technology research. Because he stays well-informed and encourages the research community to address interdisciplinary opportunities, the program officer is well-poised to take advantage of these agency-wide initiatives.	Yes.

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The program supports a wide range of projects, including small and large grants, as well as single and multiple-investigator grants. As mentioned in bullet 3, the award sizes are too small on average.	Yes.
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: The program officer actively encourages applications from young scientists and researchers who have not previously been supported by the NSF. These proposers have a success rate similar to that for the overall program.	Yes.
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: If the statistics for the magnetospheric program are consistent with those for the UARS program as a whole, then the program is well-balanced geographically.	Probably
9. Does the program portfolio have an appropriate balance of: • Institutional types? Comments:	Probably

If the statistics for the magnetospheric program are consistent with those for the UARS program as a whole, then the program is well-balanced by institution.	
10. Does the program portfolio have an appropriate balance: ▲ Across disciplines and sub disciplines of the activity? Comments: Although no breakdown versus discipline has been provided, it is clear from the list of proposals and PIs that a broad range of activities is funded.	Yes.
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The number of proposals from female and minority principle investigators is low, though success rates for these groups do not differ from those of the program as a whole within statistical margins. Both groups remain under-represented in our research discipline.	Yes.
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The magnetospheric program is an active participant in the National Space Weather Program, supporting activities that improve both first-principle and empirical models for the magnetospheric environment in which astronauts and spacecraft operate. The magnetospheric program is aligned with the Decadel Survey, for example its support for arrays of ground-based instruments. The magnetospheric program encourages proposals to agency initiatives such as cyber-infrastructure and supports their evaluation by identifying appropriate referees.	Yes

13. Additional comments on the quality of the projects or the balance of the portfolio:

The COV was concerned that the magnetospheric program is failing to take advantage of the insight that might be gained from studies of phenomena better exemplified in the magnetospheres of other planets. The COV encourages the NSF's magnetospheric program to approach the astronomy division with a view towards encouraging studies of comparative magnetospheres.

The COV commends the magnetospheric program's efforts to ensure proper access and archiving to the wealth of magnetometer observations obtained from projects supported by the NSF and other agencies. A grant to (ATM-0646323) Gjerloev at JHU/APL ensures access to both the original observations, tools to interpret them, and advanced analysis projects.

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:

From all aspects considered, the program is healthy and well-managed.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:

The program is highly responsive to emerging research opportunities. Particularly notable is the willingness of the program to complement new NASA missions and to work with other NSF initiatives like the plasma initiative. The magnetospheric program participated heavily in an important joint modeling initiative with NASA.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:

The GEM steering committee is a grass roots community activity that provides scientific guidance and advice to the MAG program that influences the planning and prioritization process to keep the focus on forward thinking and current research topics within the GEM focus areas. The program director also maintains dialogs and formal relations (for example the NASA-NSF partnership for space weather modeling) with other federal agencies (e. g. NASA, DoE, DoD, NOAA) that have been productive, avoids duplication, and increases the resources to make progress in various additional research areas. Since the last COV the fraction of the program devoted to the base program has remained nearly the same at slightly over half the program. The MAG COV feels that the base program maintains the vitality and flexibility of the funding portfolio. It provides the MAG program officer flexibility to manage the program and to support new ideas and emerging areas. The level of the core program should be maintained or increased if possible. There is adequate support given to new faculty (CAREER and FDSS awards) and to students demonstrating the dedication of the MAG program to the future of the community. Similar planning and prioritization should continue.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: The MAG program has been responsive in continuing its good management and support of science and programs with high merit. While there were no specific recommendations to the program, there was a concern about the panel review process. It was recommended generally to UARS that at least two panelists review each proposal and that has been implemented in the MAG program panels.

5. Additional comments on program management:

Due to budget limitations, the MAG program manager has made little use of site visits to evaluate the performance of projects. Site visits would be useful in the evaluation of infrastructure awards such as those for magnetometer arrays and other instruments. There is concern that the instruments be maintained, the data be of high quality and available to the broad community and easily accessible, and that the data be utilized. This may be best evaluated through a site visit. The site visit also shows the PI that the program considers the measurement efforts to be important and accountable. This may also be appropriate for other significant projects or groups in the portfolio, for example the development of new space research groups resulting from FDSS hires. Management by “walking around” is always a good idea. The COV feels that the program manager is well connected to the community through contact and participation in science meetings, however, visiting the community in their own ‘turf’ is also advised.

PART B. RESULTS OF NSF INVESTMENTS

.
The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 <u>OUTCOME GOAL for Discovery: "</u>*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments: Most scientific progress comes from the accumulation of small careful steps, some in the wrong direction and some along a productive path. Occasionally, new and exciting outcomes happen, often obtained serendipitously—which is an argument to build the base programs rather than expand top down driven special initiatives. The attached advances have come from GEM (a program developed from grass-roots community driven priorities) and the base program.

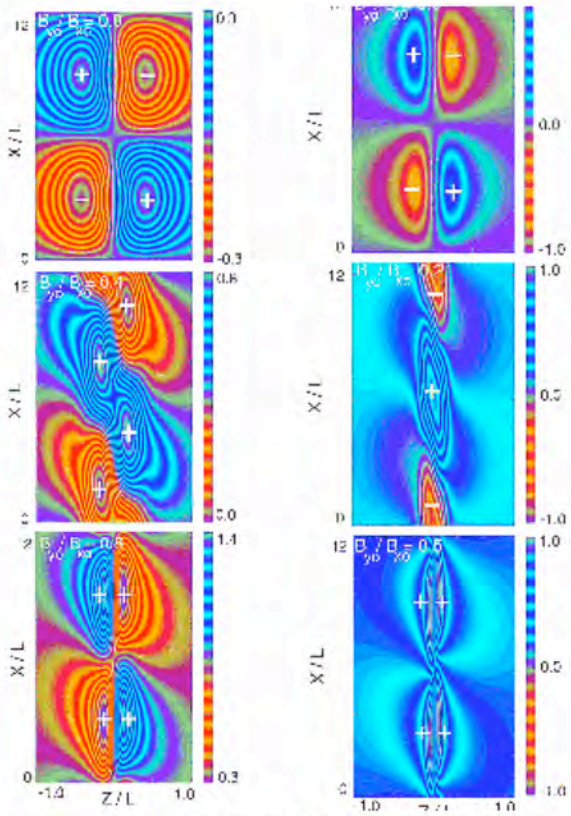
A new type of magnetic reconnection

Highlight ID: 11442

Magnetic reconnection is one of the most important processes for transporting energy, momentum and mass within a plasma. It is the primary mechanism for the coupling of the solar wind to Earths magnetosphere and it also plays a critical role in the structuring and dynamics of the magnetotail. Two competing models of magnetic reconnection at the magnetopause have been proposed. The antiparallel merging model predicts that reconnection will occur where the lines of magnetic force are most nearly oriented in opposite directions. The component merging model predicts that the reconnection line passes through the subsolar point. The component merging model allows for magnetic reconnection in the presence of a guide magnetic field.

Recent work by Daughton and Karimabadi (2005, *J. Geophys. Res.*, **110**, A03217, doi:10.1029/2004JA010751) have examined the linear theory of the collisionless tearing mode using analytical methods and particle simulations. They find that there are three distinct parameter regimes, which depend on the degree to which electron orbits are modified by the guide field in the current layer. The weak guide field corresponds to the antiparallel merging model, while the strong guide field corresponds to the component merging model. Daughton and Karimabadi have found that the intermediate strength regime, where the electrons are transitioning from unmagnetized orbits to magnetized orbits can play in important role in reconnection that is strikingly different from the other two regimes. In both the weak and strong guiding field limits, the tearing mode wave vector is perpendicular to the electric current. However, in the intermediate regime, the fastest growing modes have a wave vector that has a component that is parallel to the current.

The figure shows the results of the particle simulations. The left panels show the the simulation results for a proton to electron mass ratio of 100, while the right panels show the results for a realistic mass ratio of 1836. The top panel shows the weak guide field (antiparallel merging) limit, the middle panel shows the newly discovered intermediate regime, and the bottom panel shows the strong guide field (component merging) limit. The color contours indicate the strength of the out-of-plane component of the magnetic field. Note that both the weak and strong limits result in a quadrupolar structure, while the intermediate regime is strikingly different. The differences in the results for the different mass ratios also points out the importance of using a realistic mass ratio, particularly in the intermediate regime where the double peaked structure in the low mass ratio simulation has been replaced by a compressed, single peak structure for the realistic mass ratio.



Color contours indicate the strength of the magnetic field pointing out of the plane. Blue indicates a magnetic field pointing toward the observer, while red indicates a magnetic field pointing away.

The top and bottom panels show the standard reconnection regimes, anti parallel merging (top) and component merging (bottom). The middle panel shows the newly discovered intermediate regime, where the quadrupolar structure becomes highly distorted.

Permission Granted
Credit: H. Karimabadi and W. Daughton

Primary Goal Indicators:

- Contributions

Secondary Goal Indicators:

- Collaborations

This work is notable because:
Magnetic reconnection plays an important role in many plasmas. This research shows that reconnection can take place in a parameter regime that doesn't fit either of the two standard models.

NSF Award Numbers:

9901665

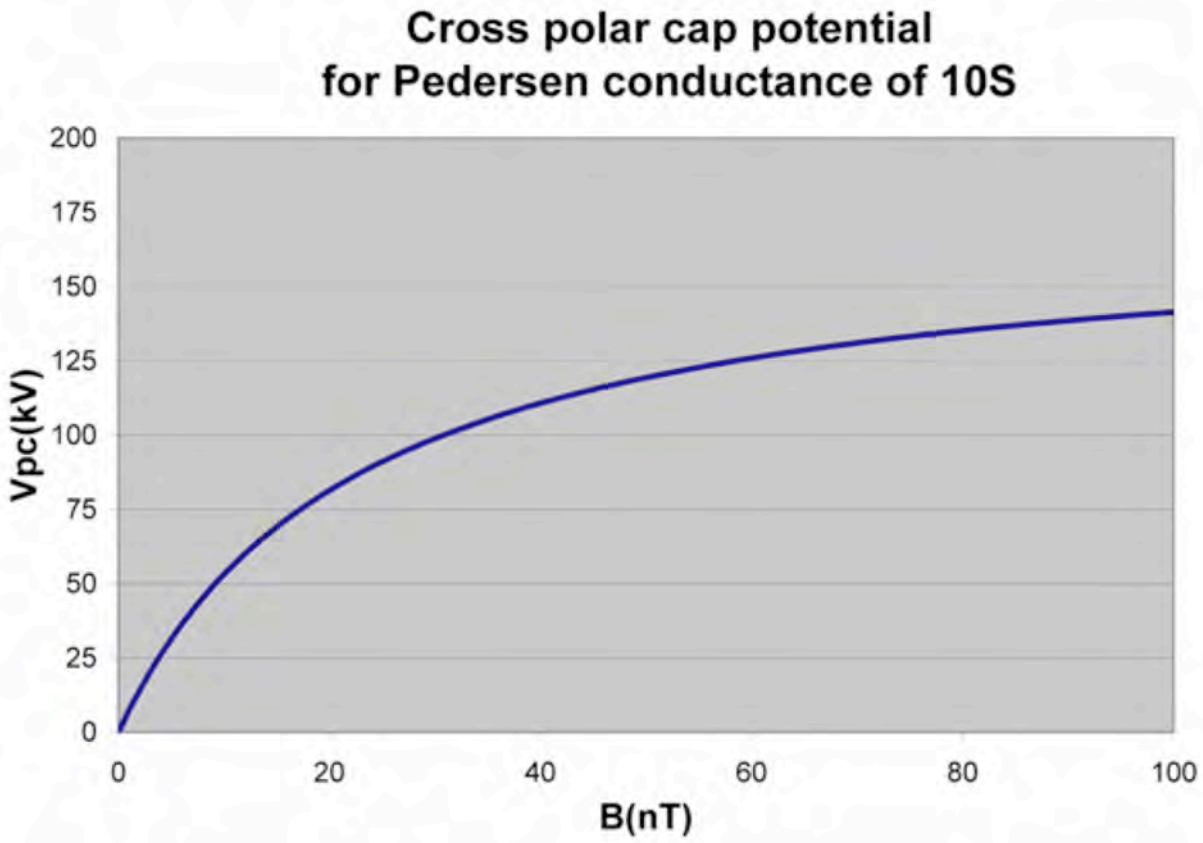
Award Title: Kinetic Simulations of Magnetopause Including Ionospheric Effect

PI Name: Homayoun Karimabadi

Institution Name: University of California-San Diego

Saturation of the Electric Potential Drop in Earth's Polar Caps

Highlight ID: 13222



Cross polar-cap potential drop predicted by the Alfvén wave theory of the interaction of the solar wind with Earth's magnetosphere. In this example, the Pedersen conductance in the ionosphere is set to 10 Siemens. The strength of the magnetic field in the solar wind is given in nanotesla.

Permission Granted
Credit: Kivelson and Ridley, 2007

The electric field carried by the solar wind interacts with Earth's magnetic field and generates an electric field in the ionosphere of Earth's polar caps. For low values of the solar wind electric field, the potential drop across the polar cap responds in an approximately linear fashion. However, when the strength of the solar wind electric field becomes strong, the magnitude of the polar cap potential drop appears to saturate. Thus, the magnitude of the potential drop rarely exceeds 200 kilovolts, despite the fact that a linear response to the solar wind would be expected to generate a drop of many hundreds of kV. This has direct implications to the question of how large an effect a major magnetic storm can produce in Earth's atmosphere.

Various explanations for the saturation phenomenon have been offered but all the mechanisms involve some sort of change to the structure of the out magnetosphere that changes the efficiency of magnetic reconnection at the dayside magnetopause. Prof. Margaret Kivelson (UCLA) and Prof. Aaron Ridley (Univ. of Michigan) have used studies originally carried out by Kivelson for the moons of Jupiter to offer a different explanation. They point out that the interaction of the solar wind electric field with Earth's magnetic field can be analyzed in terms of Alfvén wave theory (Alfvén waves are basically electromagnetic waves propagating in a highly conducting plasma). In their explanation, Alfvén waves incident from the solar wind are partially reflected, rducing the signal in the polar cap. This is very similar to the problem of an impedence mismatch in standard wave guide theory. The final mathematical relationship Kivelson and Ridley derive is very similar to the results previous investigators have derived, but the physical mechanism is quite different in that the explanation places no constraints on the efficiency of magnetic reconnection or the geometry of the magnetopause.

Primary Strategic Outcome Goal:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and

potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

Secondary Strategic Outcome Goals:

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The phenomenon of polar cap potential saturation has been a major topic of interest in the past few years. The work described here makes a major new contribution to the discussion. It also highlights the importance of cross-disciplinary studies, since the orginal work by Kivelson that prompted this new explanation was done as a comparative study of the magnetospheres of the different moons of Jupiter. It is advancing the frontiers of our understanding of Earth's interaction with the solar wind and the phenomena that drive space weather.

NSF Award Numbers:

0205958
Award Title: Scale and Rotation: Understanding the Structure and Dynamics of the Magnetospheres of Jupiter, Ganymede, and Earth
PI Name: Margaret Kivelson
Institution Name: University of California-Los Angeles
PE Code: 5750

0417839
Award Title: Space Weather: Advancement and Validation of Real-Time Assimilative Mapping of Ionospheric Electrodynamics (AMIE) for Space Weather Applications
PI Name: Aaron Ridley
Institution Name: University of Michigan Ann Arbor
PE Code: 5750

0325332
Award Title: Collaborative Research: ITR: Prototype, High-Performance, Threat-Adaptive, Space Storm Simulation and Forecast Model Supported by a Data Assimilative, Grid Computing Infrastructure
PI Name: Tamas Gombosi
Institution Name: University of Michigan Ann Arbor
PE Code: 1687

The Mid-latitude ionospheric trough and the plasmapause

Highlight ID: 11439

The ionospheric trough is a narrow, longitudinally extended region of the ionosphere where the plasma density is unusually low. It lies just equatorward of the auroral region. Some researchers have suggested that the trough represents the boundary between mid- and high-latituded regions where the ionization is produced by different mechanisms. Others have suggested that the trough has a direct connection to the equatorial plasmapause. The plasmapause is the boundary between the region in space where the plasma co-rotates with the earth and the region outside where the plasma motion is controlled by the convective electric field.

Recent work by Yizengaw (Kassie) and Moldwin has provided firm observational evidence that the ionospheric trough has a direct connection to the plasmapause. The result was deemed of sufficient importance that it was chosen for the cover page of the May 16, 2005 issue of *Geophysical Research Letters*. Yizengaw and Moldwin used new techniques in ionospheric tomography to produce detailed images of the ionospheric trough and then related that image with images of the plasmasphere and plasmapause obtained from NASA's IMAGE satellite.

Primary Goal Indicators:

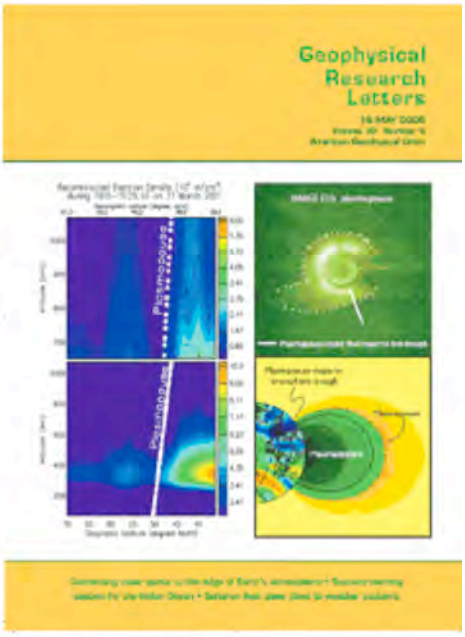
- Contributions

Secondary Goal Indicators:

- Greater diversity
- Instrument technology

This work is notable because:
This research has provided clear observational evidence to settle a long standing controversy in magnetosphere-ionosphere physics. It should also be noted that the first author is a member of an under-represented group (black).

Other Indicators (Is this work transformative or multidisciplinary?):



Cover page from the 16 May 2005 issue of Geophysical Research Letters. The images show how the ionospheric trough maps to the equatorial plasmapause.

0348398

Award Title:	Magnetometers along the Eastern Atlantic Seaboard for Undergraduate Research and Education (MEASURE-II): A Ground-Based Plasmasphere Monitor Array
PI Name:	Mark Moldwin
Institution Name:	University of California-Los Angeles

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."*

Comments:

Geospace Environment Modeling Workshops

The summer GEM Workshops support, on the average, about 60 graduate and a few undergraduate students to attend a workshop style meeting devoted to Magnetospheric research. There are special student tutorials and activities, poster sessions and opportunities for students to become more integrated into the research community.

Award number: 0401812
PI. Frank Toffoletto
Title: "GEM: Coordination for the Geospace Environment Modeling Workshops"
Institution: Rice University

Space Weather Outreach Program

Provides a broad range of scientific outreach initiatives to the public including: 1. Space weather center web site, 2. Exhibits for science center and shopping malls, 3 radio programs on space weather in both English and Spanish, 4. The Family Guide to the Sun, 5. Teacher development workshops.

Award number: 044883
PI. Paul Dusenbery
Title: "Space Weather Outreach Program"
Institution: Space Science Institute

CAREER

We note also that Career proposal have educational components and MAG is currently supporting seven Career Awards, about half going to young women faculty.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

New Magnetometers Developed for McMac Project

Highlight ID: 10041

A new chain of high resolution magnetometers for sensing variations in the magnetic field at the earth's surface is being developed. This project, known as the **M**id-**c**ontinent **Ma**gnetoseismic **C**hain (McMac) is developing and deploying a new type of magnetometer that has a lower level of instrument noise (and hence greater sensitivity) and an increased sampling rate.

By observing magnetic pulsations with periodicities of 1/2 second or longer, the density structure of the earth's inner magnetosphere can be probed. The technique draws on mathematical methods developed for the inversion of seismic waves on earth and is being referred to as magnetoseismology (similar to the interpretation of solar pulsations being called helioseismology).

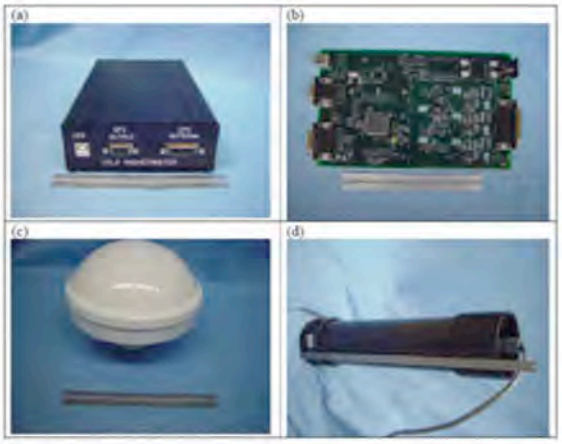
The new magnetometers, pictured below, will be set out in a chain along a magnetic meridian running downthe center of the North American continent. Data from these new magnetometers is being made available to the general scientific community through the UCLA magnetometer data center.

Primary Goal Indicators:

- Instrument technology

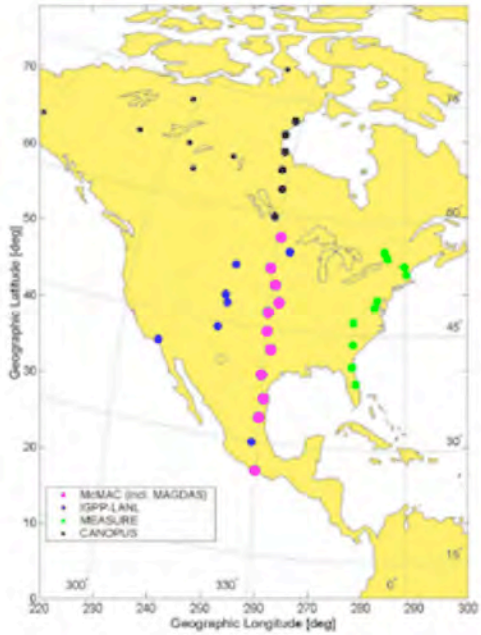
Secondary Goal Indicators:

- Contributions
- Collaborations
- Global S&E workforce
- Expand access



(a) Electronics unit for data acquisition and control; (b) circuit board stored in the box (a); (c) GPS antenna; (d) Thermally insulated tube that contains the 3-component magnetic field sensor.

Permission Granted
Credit: Pi-Jen Chi, UCLA



Locations of McMAC magnetometers relative to other magnetometer arrays nearby.

This work is notable because:
Magnetometers have been a primary ground-based source of data for space physics research for literally hundreds of years. The new magnetometers being developed at UCLA extend the capabilities of these traditional instruments and open up new research opportunities.

NSF Award Numbers:

0245139
Award Title: Mid-Continent Magnetoseismic Chain (McMaC)

PI Name: Pi-Jen Chi

Institution Name: University of California-Los Angeles

The MAG program contributes to the support of the Community Coordinated Modeling Center which supports the MAG community by providing 'runs on request' for numerical simulations investigations. The statistics of usage indicate that this resource is widely utilized. An example of MAG support related to the CCMC is the funding for "Metrics-Based Evaluation of Science Based Validation of Space Physics Models at the Community Coordinated Modeling Center (CCMC)."

Award: 0224475
Principal Investigator: Michael Hesse
Institution: NASA Goddard Space Flight Center

The MAG program also contributes to the support of the SuperDARN ionospheric radars. This coordination is provided by the SuperDARN group, formerly at the Applied Physics Lab and recently moved to Virginia Tech. The SuperDARN global distribution of radars provides one of the most fundamental parameters that characterize the coupling between the solar wind, magnetosphere, and ionosphere – the cross polar cap electric potential.

Award: 0418101
Title: SuperDARN Radar Investigations of Global Processes in the High Latitude Ionosphere: Infrastructure, Community Support and Science
Principal Investigator: Mike Ruohoniemi
Institution: JHU Applied Physics Lab

FY 2008 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV:
Program/Cluster/Section: STR
Division: UARS
Directorate: GEO
Number of actions reviewed: **Awards:** **Declinations:** **Other:**
Total number of actions within Program/Cluster/Division during period under review: 289 **Awards: 107** **Declinations: 177** **Other: 5**
Manner in which reviewed actions were selected: **18 were pre-selected, the rest were requested by the COV panelists.**

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

Briefly discuss and provide comments for *each* relevant aspect of the program's review process and management. Comments should be based on a review of proposal actions (awards, declinations, and withdrawals) that were *completed within the past three fiscal years*. Provide comments for *each* program being reviewed and for those questions that are relevant to the program under review. Quantitative information may be required for some questions. Constructive comments noting areas in need of improvement are encouraged.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The proposals submitted to the core program are evaluated through mail-in reviews, while there are both mail-in reviews and panels for special programs. When there are panels, it is not very clear how much weight is put on the mail-in reviews. We encourage the program to continue the tradition of mail-in reviews for the core program.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: While the program officer's review analysis and the panel summaries have always explicitly addressed both criteria, this is not true with the individual reviews. In some cases the reviewers do not comment explicitly on the criteria, but include them in their general summaries. In the case of proposals submitted to the NSWP, occasionally, the broader	For the most part

[1] If "Not Applicable" please explain why in the "Comments" section.

impacts that are mentioned are not broad in the sense that the contribution are mainly scientific with little cross-over into related fields, and sometime the reviewers merely paraphrase the words of the proposers in this regard.	

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: In general most reviewers provide substantive comments and adequate justification for their assessments. However, there were a minority of reviewers whose comments were too brief to justify their rating, whether high or low. Fortunately, it appears that this is a small enough minority that it does not appear to jeopardize the review process.	For the most part
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: The summaries examined were all consistent with the final rating of the proposals.	yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: The examples we have seen are excellent and give a very clear view of the process, and assuming that this is a representative sample, we think that the information is more than adequate.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: In the case of clear acceptances or rejections, the rationale for the decision seems to be clear. However, in the case of rejection despite high scores, the reason may not be very clear to the PI. The PI should be encouraged to call the Program Officer to get more details in those cases.	Usually
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments: The Program Officer is to be commended on doing better than the performance goal.	Yes

8. Additional comments on the quality and effectiveness of the program's use of merit review process:

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: On the whole the reviewers were well qualified. In cases when there was a reviewer who was not an expert in the subject area of the specific proposal under review, it is usually obvious. In most cases other reviewers compensate for that,	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: Since these data were not always available, we cannot make a definite statement, however, it does seem reasonably balanced with respect to gender and geography.	It appears so
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments:	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: The overall quality of the core, SHINE, NSWP and FDSS proposals that were reviewed were high. It is unfortunate that some of the highly rated proposals had to be turned down.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: The FDSS, CAREER and REU grants are the main vehicles by which research and education have been integrated explicitly. Many of the other proposals also support undergraduate and graduate students as well as postdoctoral fellows and hence, advance the cause of both research and education.	Yes
3. Are awards appropriate in size and duration for the scope of the projects? Comments: While the duration of the projects appears to be appropriate, the COV members feel that the award size is perhaps smaller than what is really	Somewhat appropriate

[3] If "Not Appropriate" please explain why in the "Comments" section.

required to carry out the project successfully.	
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: None of the 22 jackets that we reviewed falls under this category, However, there are nearly 300 proposed programs, of which slightly more than 100 were awarded, and we cannot be sure without reviewing the other cases whether or not any of those fell under this category.	Cannot judge
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The NSWP proposals are by their very nature multidisciplinary. There were also some examples of interdisciplinary proposals bridging solar physics and stellar astrophysics.	Appropriate

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: We can only really comment about the cases we have read, but assuming that they are a representative sample it appears so, though the award sizes appear small.	Yes
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments:	Yes
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: Given the geographical distribution of institutions where STR work is carried out, the geographical distribution of PIs is balanced.	Yes
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments:	Yes
10. Does the program portfolio have an appropriate balance: ▲ Across disciplines and sub disciplines of the activity? Comments:	yes

11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: The statistics for the gender distribution shows a balance. The statistical table for other minority groups is incomplete, but the numbers appear to be small.	Yes
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: This is amply demonstrated in the FDSS program. The NRC decadal survey report, "Sun to Earth – and Beyond" (2003), had recommended that NSF take action to give funds to universities to create tenure track faculty positions, and the FDSS does that. The FDSS program was also recommended by the report of the Assessment Committee for the National Space Weather Program (2006). In terms of facilities, partial funding of FASR, was recommended by the NRC report too.	Yes
13. Additional comments on the quality of the projects or the balance of the portfolio: For the last fiscal year under review, STR seems overly burdened with commitments to the FDSS and CAREER programs. While it is extremely important to support new faculty, some action should be taken to ensure that it is not at the expense of the core program only, as it clearly has been in FY2007, but that the burden is distributed throughout the program.	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments: The program is very well managed. The PIs are given adequate feedback in an appropriate amount of time. The award portfolios seem to be as well balanced as can be under present constraints. This has been possible only because of good management.

2. Responsiveness of the program to emerging research and education opportunities.

Comments: The program appears to be responsive to opportunities in education. Its support of FDSS and CAREER grants as been commendable. In terms of research, the program has been supportive of emerging research, though it must be said that for the period under review there have been no overwhelming changes to the field, and hence the question cannot really be answered fully.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments: From the material and presentations that we had access to, we are led to believe that highest priority is given to proposals with the most scientific merit. The next level of priority is to young and upcoming investigators, while at the same time trying to ensure diversity of P.I.s .

The program has reacted admirably to external recommendations for faculty development grants and undergraduate education.

Our concern for the program lies in the fact that because of pre-commitments of money into specific program elements such as SHINE, NSWP and FDSS, there seems to be very little room for proper planning of the core program. While, given the constraints, the portfolio of awards is balanced with respect to sub-discipline and sub-field, this is not an optimal situation, particularly since the award sizes are forced to be small and there can be very few new awards each year. Thus we feel that pressure on the core program should somehow be reduced.

4. Responsiveness of program to previous COV comments and recommendations.

Comments: We find that the program has been very responsive to the comments and recommendations of the previous COV. In particular, the use of virtual panels to mitigate group dynamics in a review panel is a very positive change. Also the fact that although STR does not cover the full heliosphere, they have funded related projects.

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

.
The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments: Investigations supported by STR have led to several significant and interesting results. We highlight a few results below.

(1) *Coupled MHD-SEP simulations of heliosphere:* P.I. Ilia Roussev (award # 0454469). The P.I. utilized high-resolution solar magnetic field data to set more realistic boundary conditions for simulating the radial magnetic field at the Sun's surface. This allowed him to develop new theoretical methods for CME initiation by imposing physically self-consistent electric field evolution in the vicinity of solar magnetic eruptions. See Fig STR-1

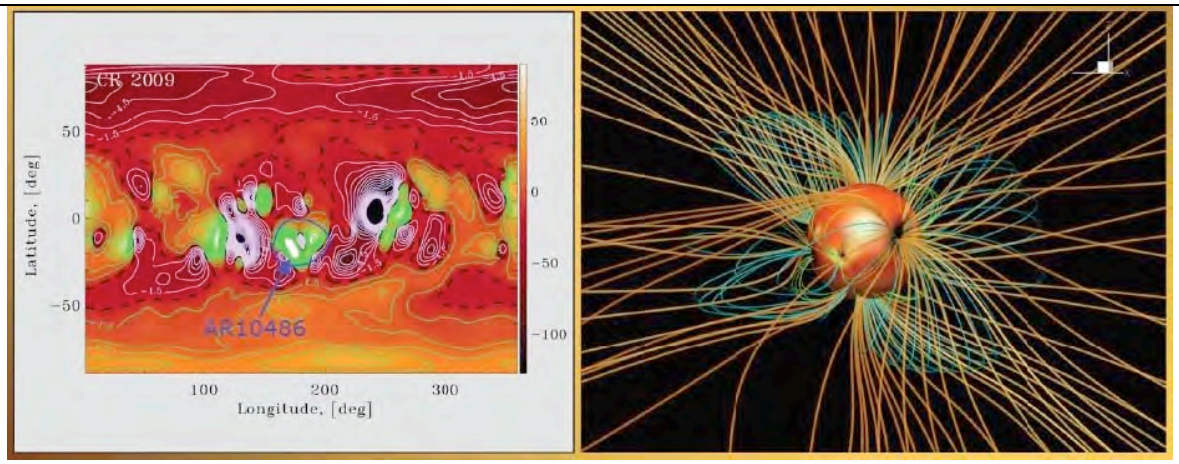


Fig STR-1 Real Magnetic Data Drive MHD Simulations: *(Left) Map of the radial component of the Sun's magnetic field preceding the CME of Oct 28, 2003; (Right) Computed steady-state coronal magnetic field for the same date, with solar wind flow vectors. The CME later erupted from the active region labeled "AR10486" in blue.*

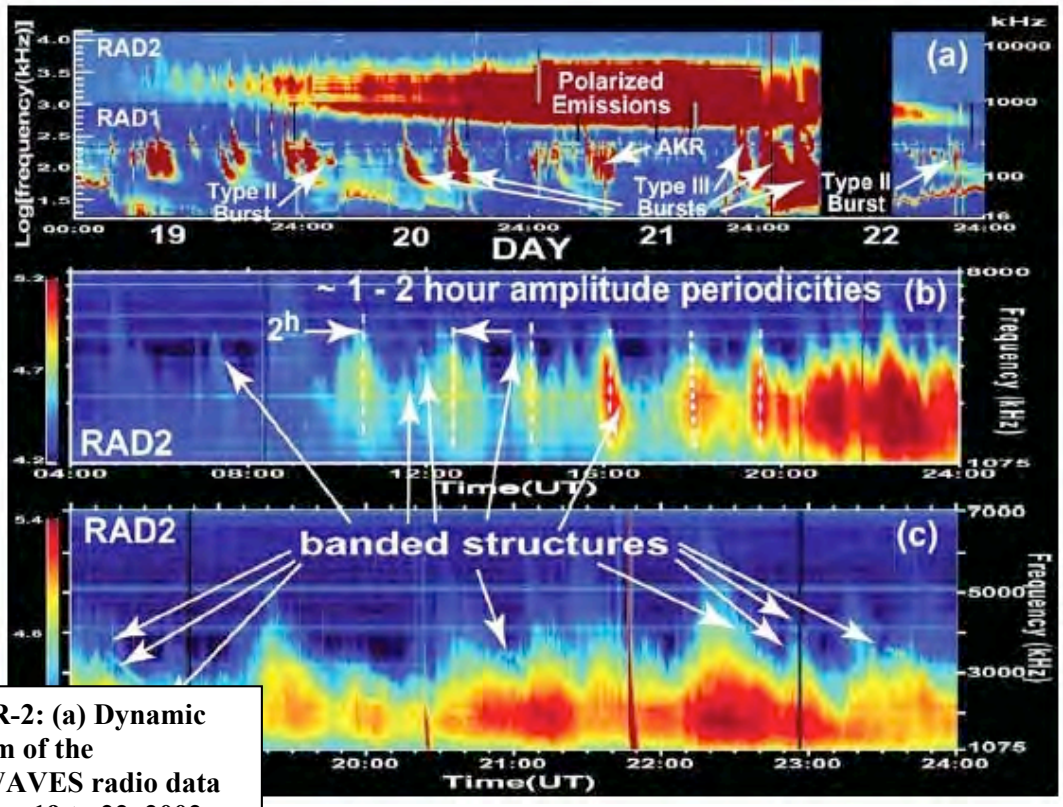


Fig. STR-2: (a) Dynamic spectrum of the Wind/WAVES radio data from May 19 to 22, 2002. (b) High time resolution dynamic spectrum of the Wind/WAVES radio data from one to eight MHz on May 19, 2002, showing the amplitude periodicity of the emissions. (c) High time

(2) *Space-based detection of circular polarization in solar Radio storms:* P.I. M. Reiner , Award #0417695. The P.I.'s investigation of Type III radio bursts showed that roughly 5% of these bursts show circular polarization. The electron beam associated with Type II

bursts propagate through the heliosphere, generating radio waves. The frequency and polarization states of these bursts directly measure the interplanetary plasma density and magnetic field along the path of the electron beam.
These measurements may provide information on the physical conditions required for CME initiation and release and hence have implications for space weather forecasting. See Fig STR-2

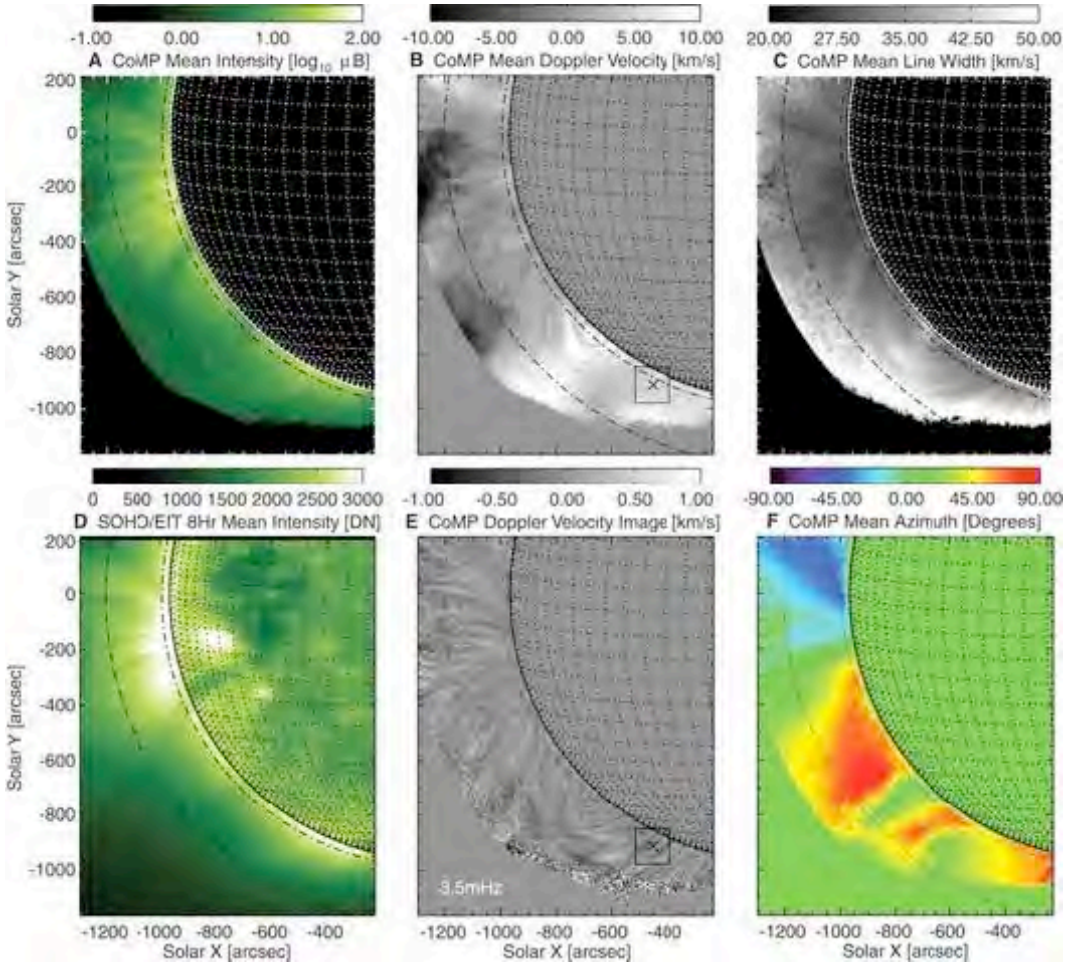


Fig. STR-3 From left to right, top to bottom: *CoMP observations of time-averaged intensity (A), Doppler velocity (B), line width (C), SOHO/EIT 19.5-nm imagery (D), 3.5-mHz filtered Doppler velocity (E) and plane of sky magnetic field azimuth direction (F). Note that 'DN' (data number) is a unit of brightness. Image s (B) and (E) indicate a region (X) used by investigators for Alfven wave travel-time analysis. The curved dot-dashed lines represent distances of 0.05 and 0.25 solar radii above the Sun's limb.*

(3) *The detection of Alfven waves in the solar corona*: Using the Coronal Multi Channel Polarimeter that was developed by STR award # 0541567, P.I. Scott McIntosh and his collaborators showed that the Alfven waves flowed from the solar interior through the chromosphere. Using the same instrument, Steven Tomczyk measure Alfven waves in the solar corona. These waves are believed to be a source of coronal heating. By tracking the speed and direction of such waves McIntosh and hic colleagues will be able to infer basic properties of the solar atmosphere such as, density and the direction of magnetic fields. See Fig. STR-3

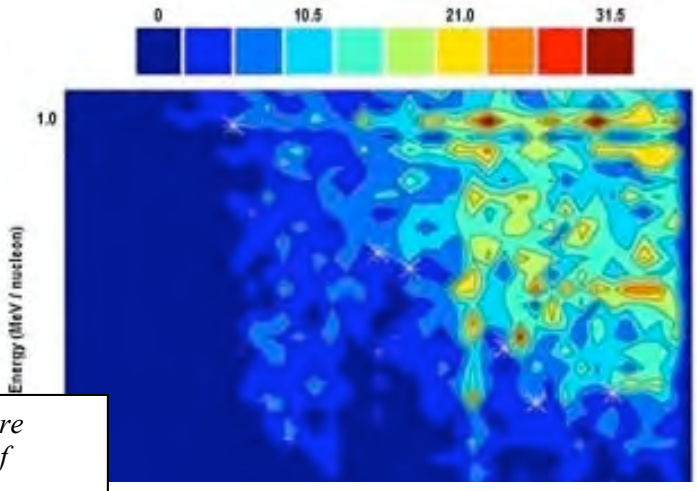


Fig. STR-4. *This figure depicts occurrences of sharp, intermittent concentrations of ions (colorful yellow-reddish 'blobs') from a solar flare arriving at a spacecraft*

(4) *Early arrival of solar energetic particles may help forecast space weather*: P.I. Joseph Giacalone (award # 0447354) and his students analyzed solar energetic particles from solar flares with unusual characteristics. The particle emission from these flares exhibited unusual phenomena such as dropouts in the particle intensity and anomalous bursts of low energy particles. The anomalous burst arrived earlier than expected. These particles can also be observed inside interplanetary CMEs, and hence, may provide key information about the magnetic structure of the ICME cloud. This is critical in predicting whether or no the ICME plasma will cause significant geomagnetic storms.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."*

Comments: STR has supported the creation of a science workforce directly through support of the FDSS program. The FDSS programs supported by STR include awards to the University of Colorado(P.I. Baker, award #0457552) , University of Arizona (P.I. Jokipii, award # 0457631) and the University of Hawaii (P.I. Kuhn, award # 0456971) to develop faculty positions in space sciences.

STR has also helped new faculty through several CAREER grants. Among these is award #0447354 to P.I. Joe Giacalone of the University of Arizona. The P.I.'s program, entitled "*Integrated Research and Education in Solar Physics, Space Weather, and Energetic Charged Particles"* has enabled him to do cutting edge work in the field of solar energetic particle. This award has also enabled him to develop the first graduate-level solar physics course in the Dept of Planetary Sciences at the University of Arizona. Dr. Giacalone has also formed a joint University of Arizona - NSO Summer School on Solar Physics, held annually since 2006 in Sunspot, New Mexico.

STR's vehicles for spreading science literacy are the REU programs supported by STR. A few examples are below.

(1) REU at *Prairie View A&M University,* P.I. Tian-Sen Huang, Award #0453519. The Prairie View Solar Observatory (PVSO) provides opportunities for students to investigate space physics problems. Student projects include the study of solar activity based on observations performed at PVSO and computer modeling to ascertain the response of Earth's magnetosphere and ionosphere to solar activity.

Fig. STR-5*: The Prairie View Solar Observatory (Right) provides opportunities for students (Left) to investigate space science.*

(2) REU at *Montana State University*, P.I. David McKenzie, Award # 0552958. This REU site has been funded since 2003. This program provides students with solar physics projects using data from ground and space based observations. The educational program includes tutorials on solar and space physics, data analysis software and web page development, science and research ethics, etc.

B.3 <u>OUTCOME GOAL for Research Infrastructure: "</u>*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments: The STR program has supported basic infrastructure in the form of instruments as well as models. We give some examples below.

(1) Instrument: *High-Resolution Imaging of the Sun Using Adaptive Optics*, P.I. Phillip Goode, Award # 0342560. The group at NJIT led by the PI has combine adaptive optics and speckle masking to produce high-resolution images of the solar surface, giving a fore-taste of what can be expected with ATST. This can image the smallest structures on the Sun, enabling the community to investigate the evolution of fine-scale solar magnetic fields.

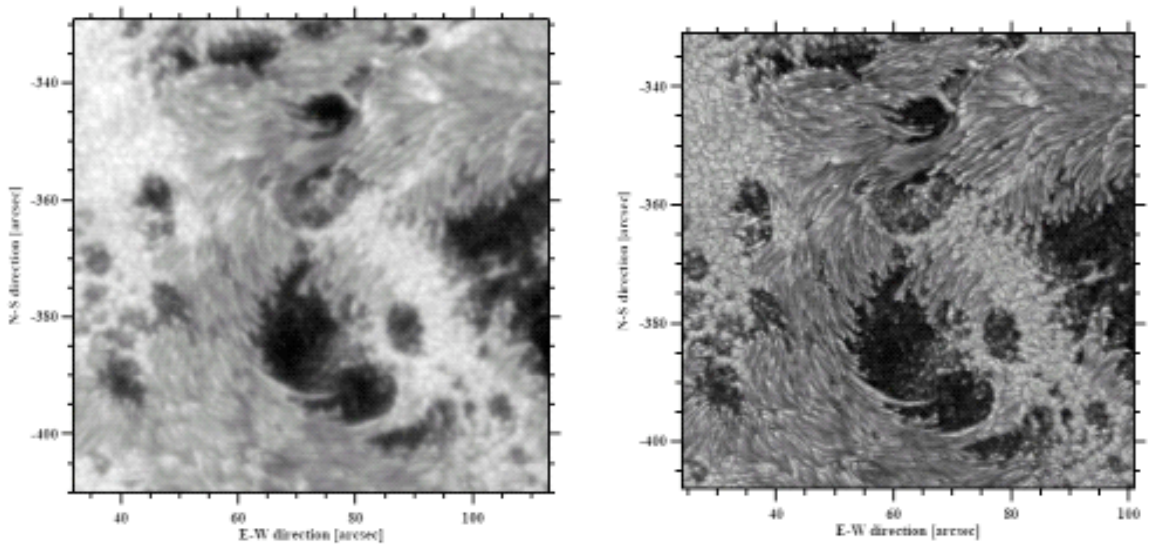


Figure STR-6: *(Left) Solar active region without AO or speckle masking and* (Right) image reconstruction with high order AO correction and speckle masking technique applied.

Figure STR-7 *Artist concept of FASR multi-frequency radiotelescope array.*

(2) Instrument: Frequency *Agile Solar Radiotelescope*, P.I. Timothy Bastian, Award #0532973. This facility, when complete, is a multifrequency imaging array composed of many antennas. It designed t o produce high quality images with high spatial resolution, high spectral resolution and high time resolution. FASR is expected to make significant new contributions solar physics, specifically in the study of the nature and evolution of coronal magnetic fields, the physics of solar flares, the drivers of space weather, etc.

(3) Instrument: *Coronal Multi-Channel Polarimeter*, P.ISteve Tomczyk, Award #0541567. This instrument can directly measure coronal magnetic fields. Earlier estimates of coronal magnetic fields mainly depended on extrapolation of photospheric fields. See also Figure STR-3.

(4) Model: Modeling *Solar Coronal Mass Ejections*, P.I. Jon Linker, Award #0454597. The team led by the PI has developed a 3D MHD model of the solar magnetic fields for CME initiations. The initial results from the models appear to agree with what is seen on the Sun. This model is an important resource that is available to the space weather community via the CCMC. See Fig. STR-8.

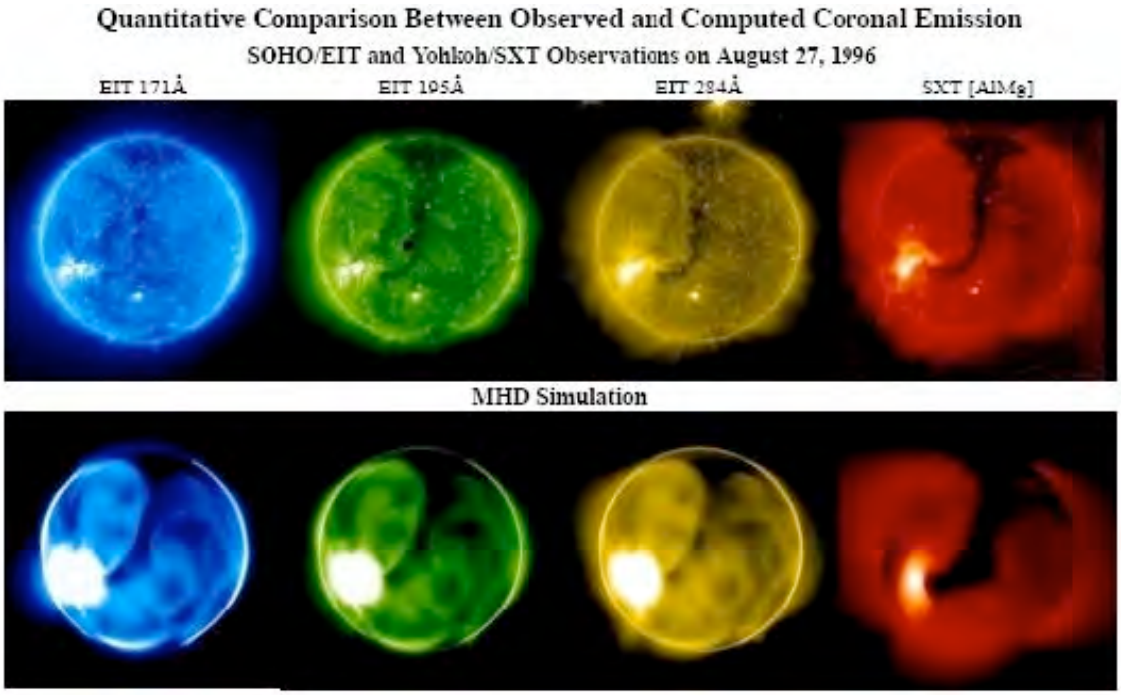


Figure STR-8: *A comparison of the Sun's actual coronal emission (top row) observed on August 27, 1996 by instruments on the SOHO and Yohkoh spacecraft with simulations (bottom row) using the SAIC MHD code. Note that the large-scale structure of the Sun's polar and equatorial*

FY 2008 REPORT TEMPLATE FOR NSF COMMITTEES OF VISITORS (COVs)

The table below should be completed by program staff.

Date of COV:
Program/Cluster/Section: UAF
Division: ATM
Directorate: GEO
Number of actions reviewed: **Awards:** **Declinations:** **Other:**
Total number of actions within Program/Cluster/Division during period under review: **Awards:** **Declinations:** **Other:**
Manner in which reviewed actions were selected:

PART A. INTEGRITY AND EFFICIENCY OF THE PROGRAM'S PROCESSES AND MANAGEMENT

The COV wishes to commend the UAF Program director for his effective management and the direction he has taken the program. The UAF program has benefited from the addition of new instrumentation, as well as new concepts to operate them. Drs. Robinson and Behnke have met the challenges to ensure future funding for the Arecibo Observatory and have developed a path towards a successful resolution. The newly operational AMISR facility has exceeded sensitivity expectations. The program has supported the high demand for observing time. The support for additional instrumentation at the facility will provide more research opportunities for the community. Competitions targeted to the use of facilities, such as the AMIR graduate studies, should be encouraged to broaden their user base. Finally, the UAF program supports excellent educational and outreach activities at the facilities.

A.1 Questions about the quality and effectiveness of the program's use of merit review process. Provide comments in the space below the question**.** Discuss areas of concern in the space provided.

QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS	**YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE[1]**
1. Are the review methods (for example, panel, ad hoc, site visits) appropriate? Comments: The methods seem to be appropriate and effective. The review process for the proposals for the operation and management of facilities helps the NSF to be aware that the facilities address community-wide interests. The reviews of the support proposals include views from a broad cross section of the community.	Yes
2. Are both merit review criteria addressed a) In individual reviews? b) In panel summaries? c) In Program Officer review analyses? Comments: Reviewers were careful to address both criteria.	Yes

[1] If "Not Applicable" please explain why in the "Comments" section.

3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals? Comments: The individual reviews provide extensive comments and were well constructive and informed. The reviewers made an effort to address the different review criteria separately.	Yes
4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)? Comments: Panel summaries were well written and provided well-organized summaries. Without access to the panel deliberations it is not possible to assess the type of consensus in detail.	Yes
5. Does the documentation in the jacket provide the rationale for the award/decline decision? (Note: Documentation in jacket usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), program officer review analysis, and staff diary notes.) Comments: Documentation includes sufficient information. In some cases it would be useful to have access to more details on the panel discussion to document dissenting views.	Yes

6. Does the documentation to PI provide the rationale for the award/decline decision? (Note: Documentation to PI usually includes context statement, individual reviews, panel summary (if applicable), site visit reports (if applicable), and, if not otherwise provided in the panel summary, an explanation from the program officer (written or telephoned with diary note in jacket) of the basis for a declination.) Comments: In most cases the individual reviews and panel summary are sufficient. Diary notes provide little additional clarification.	Yes
7. Is the time to decision appropriate? Note: Time to Decision --NSF Annual Performance Goal: **For 70 percent of proposals, inform applicants about funding decisions within six months of proposal receipt or deadline or target date, whichever is later**. The date of Division Director concurrence is used in determining the time to decision. Once the Division Director concurs, applicants may be informed that their proposals have been declined or recommended for funding. The NSF-wide goal of 70 percent recognizes that the time to decision is appropriately greater than six months for some programs or some individual proposals. Comments:	Yes
8. Additional comments on the quality and effectiveness of the program's use of merit review process:	

A.2 Questions concerning the selection of reviewers. Provide comments in the space below the question. Discuss areas of concern in the space provided.

SELECTION OF REVIEWERS	**YES , NO, DATA NOT AVAILABLE, or NOT APPLICABLE[2]**
1. Did the program make use of reviewers having appropriate expertise and/or qualifications? Comments: Success obtaining a broad range of expertise through a high number of reviews for each proposal. This is especially true of the high-budget proposals for the major facilities.	Yes
2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups? Note: Demographic data is self reported, with only about 25% of reviewers reporting this information. Comments: The representation in the reviews reflects the characteristics of the community.	Yes
3. Did the program recognize and resolve conflicts of interest when appropriate? Comments: Only one case was noted. It was handled appropriately.	Yes

[2] If "Not Applicable" please explain why in the "Comments" section.

4. Additional comments on reviewer selection:

A.3 Questions concerning the resulting portfolio of awards under review. Provide comments in the space below the question. Discuss areas of concern in the space provided.

RESULTING PORTFOLIO OF AWARDS	APPROPRIATE, NOT APPROPRIATE[3], OR DATA NOT AVAILABLE
1. Overall quality of the research and/or education projects supported by the program. Comments: Research is generally excellent. Some reviewers raised concerns that some facilities over-emphasize the scientific interests of the institutions directly related to the operation of the facility. The facilities are being exploited very effectively to educate many students.	Appropriate
2. Does the program portfolio promote the integration of research and education? Comments: There is a trend toward bringing younger people onto facility staffs. A large percentage of the publications coming from the use of the facilities have students as first author.	Appropriate

[3] If "Not Appropriate" please explain why in the "Comments" section.

3. Are awards appropriate in size and duration for the scope of the projects? Comments: The awards are appropriate considering the available funding.	Appropriate
4. Does the program portfolio have an appropriate balance of: • Innovative/potentially transformative projects? Comments: The program has encouraged and supported the implementation of state of the art technology to modernize the facilities. This modernization encourages innovative research in areas that were impossible to address with the original capabilities. A prime example is the highly-resolved images of equatorial spread-F at Jicamarca.	Appropriate
5. Does the program portfolio have an appropriate balance of: • Inter- and Multi- disciplinary projects? Comments: The radar facilities have been successful in attracting multiple co-located instruments. This development has been encouraged and financially supported by the program. The support of expansion of the facility instrumentation has expanded the possible research to address problems across the UARS.	Appropriate

6. Does the program portfolio have an appropriate balance considering, for example, award size, single and multiple investigator awards, or other characteristics as appropriate for the program? Comments: The awards are appropriate for the effective operation of the facilities.	Appropriate
7. Does the program portfolio have an appropriate balance of: • Awards to new investigators? NOTE: A new investigator is an investigator who has not been a PI on a previously funded NSF grant. Comments: The nature of the program requires experienced PIs. An appropriate balance is achieved by the inclusion of younger co-investigators.	Appropriate
8. Does the program portfolio have an appropriate balance of: • Geographical distribution of Principal Investigators? Comments: The program reflects the geographical distribution of the community.	Appropriate
9. Does the program portfolio have an appropriate balance of: • Institutionnel types? Comments: There has been very little turn-over in the institutions running the facilities. In the past three years there has been an effort to involve more institutions in facility-based research projects. The administration and support of facilities requires a minimum administrative infrastructure in the supporting research institution. This by nature weights the support towards larger research institutions and experienced administrators. More institutions are meeting that requirement, which may indicate that this is a good time to consider re-competing the management of the facilities.	Appropriate

10. Does the program portfolio have an appropriate balance: • Across disciplines and sub disciplines of the activity? Comments: The use of the facilities to address research in a broad spectrum of sub-disciplines is encouraged by the program officer.	Appropriate
11. Does the program portfolio have appropriate participation of underrepresented groups? Comments: We see no evidence of bias in this area. The location of some of the facilities ensures a large representation of Hispanic scientists.	Appropriate
12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports. Comments: The program is well aligned with agency goals and is relevant to national priories in space weather. It is supportive of, and receives support from, the space programs of NASA, NOAA, the Departments of Defense and Energy.	Appropriate
13. Additional comments on the quality of the projects or the balance of the portfolio:	

A.4 Management of the program under review. Please comment on:

1. Management of the program.

Comments:
Dr. Robinson has managed the program effectively and efficiently. He has been successful in focusing the program more directly on the support and use of the facilities by their staff and the community. He has ensured that the facilities have provided the highest quality opportunities for research, domestic and international outreach, and educational programs.

2. Responsiveness of the program to emerging research and education opportunities.

Comments:
The program manages very successful REU programs located at the facilities. Every facility has some type of student program or summer school. These programs have generally been successful in inspiring leading students to enter the field. The facilities have lead the community in promoting and facilitating the space weather program. They are aggressively pursuing new capabilities, such as the heater at Arecibo. The facilities have developed new techniques and provide unique data to study the effects of meteoric flux in the middle atmosphere. The facilities program encouraged the sharing of ideas and technology through support of the Lidar Consortium.

3. Program planning and prioritization process (internal and external) that guided the development of the portfolio.

Comments:
The program has been consolidated and is more focused. The result is that the community benefits from well run facilities and crucial data. The exchange of CEDAR Workshop support for the Lidar Consortium has made new data available from the suite of instruments supported by UAF. The program officer ensures the growth and expansion of the facilities through additional programs such as optical support for AMISR.

4. Responsiveness of program to previous COV comments and recommendations.

Comments:
No major concerns were noted by the previous COV.

5. Additional comments on program management:

PART B. RESULTS OF NSF INVESTMENTS

.
The NSF mission is to:

- promote the progress of science;
- advance national health, prosperity, and welfare; and
- secure the national defense.

To fulfill this mission, NSF has identified four strategic outcome goals: Discovery, Learning, Research Infrastructure, and Stewardship. The COV should look carefully at and comment on (1) noteworthy achievements based on NSF awards; (2) ways in which funded projects have collectively affected progress toward NSF's mission and strategic outcome goals; and (3) expectations for future performance based on the current set of awards.

NSF investments produce results that appear over time. Consequently, the COV review may include consideration of significant impacts and advances that have developed since the previous COV review and are demonstrably linked to NSF investments, regardless of when the investments were made.

To assist the COV, NSF staff will provide award "highlights" as well as information about the program and its award portfolio as it relates to the three outcome goals of Discovery, Learning, and Research Infrastructure. The COV is not asked to review accomplishments under Stewardship, as that goal is represented by several annual performance goals and measures that are monitored by internal working groups that report to NSF senior management.

B. Please provide comments on the activity as it relates to NSF's Strategic Outcome Goals. Provide examples of outcomes ("highlights") as appropriate. Examples should reference the NSF award number, the Principal Investigator(s) names, and their institutions.

B.1 OUTCOME GOAL for Discovery: "*Foster research that will advance the frontier of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering."*

Comments:

During the reviewed period, the UAF program has successfully contributed the necessary infrastructure to perform key observations and discoveries in a large number of areas. The COV recognizes the following achievements as prime examples:

-Multi-radar observations of transpolar ionospheric features obtained with the unique combination of facilities supported by the program. These are the Millstone-Hill and Sondrestrom incoherent scatter radars, the SuperDARN network and the addition of GPS measurements. The results show that electron density enhancements are produced on the dayside Earth by sunlight and then locally drawn into the polar regions by the convection electric field. After several hours the enhancement reaches across the entire polar cap, enabling it to be observed by incoherent scatter radars in Massachusetts, Greenland, and Norway. These observations confirm the origin of electron density enhancements commonly observed in the high-latitude nightside ionosphere.

-Incoherent scatter radars have provided invaluable data to address, with great sensitivity and

resolution, the influence of meteors in the middle and upper atmosphere.

-New imaging radar techniques are providing observations of small-scale irregularities in the equatorial F-region ionosphere.

B.2 OUTCOME GOAL for Learning: "*Cultivate a world-class, broadly inclusive science and engineering workforce, and expand the scientific literacy of all citizens."*

Comments:

UAF supports excellent educational and outreach activities at the facilities. Most have either an REU site , or a similar program every summer. Many of the most successful scientists in the field have started and benefited from these programs. The UAF also supports the Polar Aeronomy and Radio Science School in Alaska, which helps develop expertise in the next generation of scientists. In the past five years the four ISR facilities alone, have assisted more than 150 undergraduate and graduate students in their research. Over 100 researchers from about 50 American and international institutions have used these facilities during this time resulting in more than 500 publications. There were approximately 15 workshops hosted at the facilities during this time.

B.3 OUTCOME GOAL for Research Infrastructure: "*Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools."*

Comments:

-The deployment and successful operation of the Advance Modular Incoherent Scatter Radar (AMISR) at Poker Flat, Alaska, including test panels at the Jicamarca Radio Observatory in Peru. This is the first incoherent scatter radar designed to be modular for easy dismantling and relocation. AMISR is based on a new solid-state design that must simultaneously satisfy strict requirements on performance, robustness, manufacturability and cost. The design and development was a cooperative effort involving people with expertise in space physics, radio engineering, signal propagation, high-speed computing, and industrial engineering. The sensitivity of the radar has exceeded expectations as shown by the results derived from experiments performed during its first year of operation.

-The addition of a radar in Wallops Island to the SuperDARN network. This radar began operation in May, 2005. When measurements obtained with this radar are incorporated into the calculation of an average SuperDARN convection pattern the streamlines of polar cap outflow on the nightside are significantly different from those calculated without the mid-latitude data.

-The addition of the Consortium of Resonance and Rayleigh Lidars (CRRL) to the facility program. The nature of this consortium requires strong cooperation among academic and research institutions and brings together scientific and technical expertise. The innovative concept of the CRRL could be utilized, if proven to be successful, as the model for similar consortia among groups of facilities. Facility consortia could improve scientific and technical productivity while reducing operational costs.

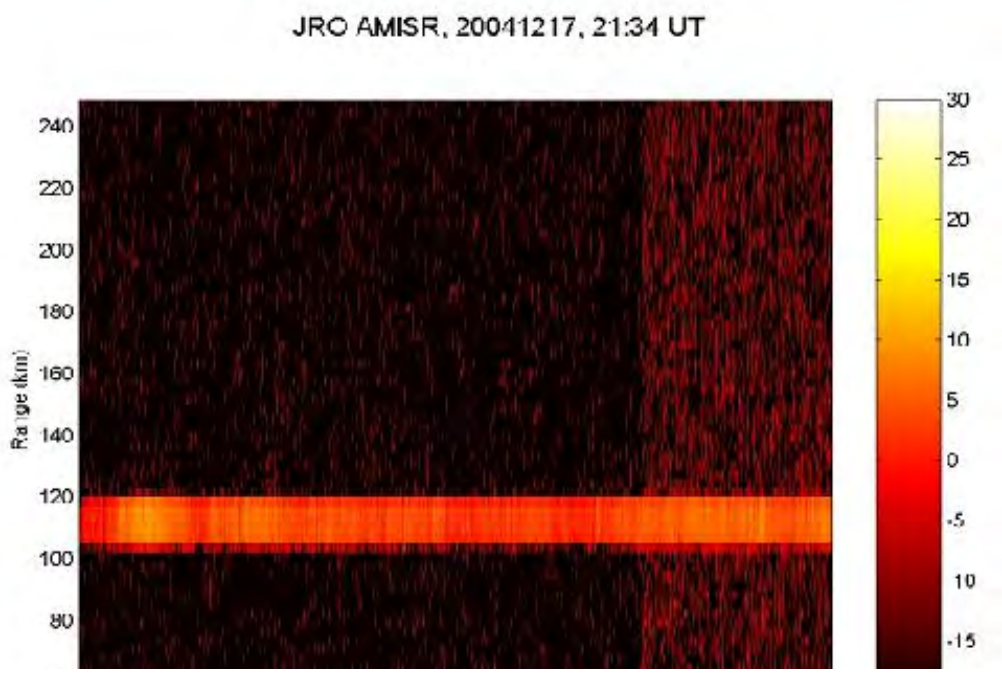
NSF Highlights

First light for the Advanced Modular Incoherent Scatter Radar (AMISR) in Peru

Highlight ID: 10086

Seven AMISR panels aligned side by side at the Jicamarca Radio Observatory in Peru. The panels are mounted on movable support structures so that different antenna configurations can be tested.

Permission Granted
Credit: Craig Heinselman, SRI International



Radar echoes from the equatorial electrojet measured by the AMISR prototype system at the Jicamarca Radio Observatory in Peru. The intense echoes between 100 and 120 km altitude represent the first measurements of the equatorial electrojet at 450 MHz.

Credit: John Kelly, SRI International

A prototype of the new Advanced Modular Incoherent Scatter Radar (AMISR) has been successfully deployed at the Jicamarca Radio Observatory in Peru. AMISR is an incoherent scatter radar operating at 450 MHz. The final system will be capable of measuring many basic properties of the upper atmosphere and ionosphere up to 1000 km altitude. Complete systems will eventually be deployed at Poker Flat, Alaska, and Resolute Bay, Canada. The radar systems in Alaska and Resolute Bay will be constructed from 128 and 256 modular panels, respectively. The panels are designed to be easily transportable by conventional shipping methods. Even though the prototype system in Peru is made from only seven panels, the radar was able to detect physically meaningful echoes from the equatorial electrojet at 120 km altitude. This represents the first observation of the equatorial electrojet at a frequency of 450 MHz. A second prototype system is currently being shipped to Gakona, Alaska, for additional testing.

Primary Goal Indicators:

- Next generation facilities and platforms

Secondary Goal Indicators:

- Expand access
- Instrument technology

This work is notable because:
This represents the successful design and deployment of a prototype system for a next-generation incoherent scatter radar.

Other Indicators (Is this work transformative or multidisciplinary?):

This work involves high risk research.
This is the first incoherent scatter radar designed to be modular for easy dismantling and relocation. AMISR is based on a new solid-state design that must simultaneously satisfy strict requirements on performance, robustness, manufacturability and cost.

This work involves multidisciplinary research.
The design and development was a cooperative effort involving people with expertise in space physics, radio engineering, signal propagation, high-speed computing, and industrial engineering.

GEO/ATM 2005

Program Officer: Robert Robinson

NSF Award Numbers:

9908951
Award Title: Design and Prototype Development of an Advanced, Modular Incoherent-Scatter Radar
PI Name: John Kelly
Institution Name: SRI International
PE Code: 4202

0089937
Award Title: Advanced Modular Atmospheric Incoherent Scatter Radar (AMISR)-Phase II
PI Name: John Kelly
Institution Name: SRI International
PE Code: 4202

0121483
Award Title: The Relocatable Atmospheric Observatory: A Global Incoherent Scatter Radar
PI Name: John Kelly

Institution Name: SRI International

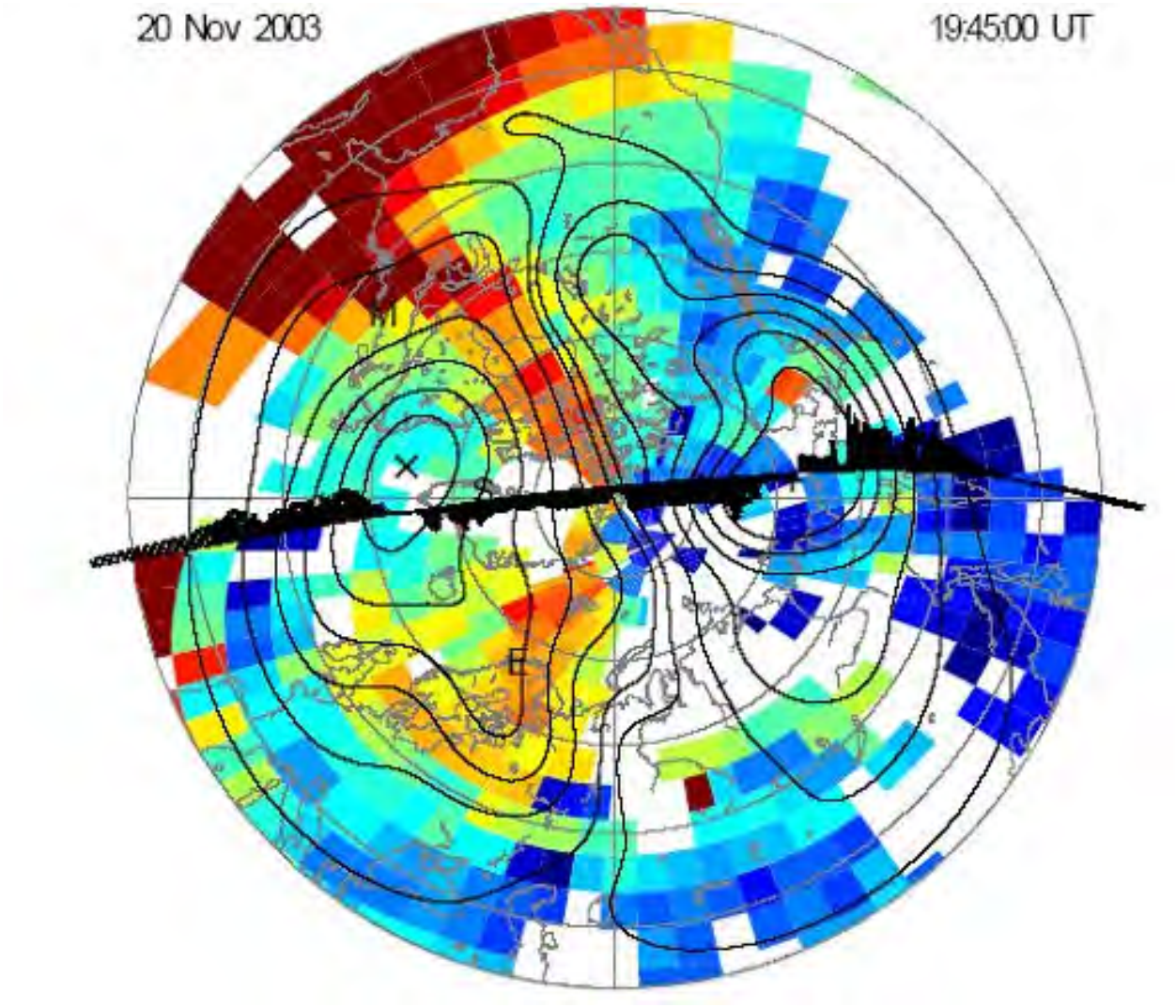
PE Code: 4202

Submitted on 01/11/2005 by Robert M. Robinson
ATM: Approved 02/15/2005 by Jarvis L. Moyers
GEO: Approved 02/16/2005 by Melissa J. Lane

NSF Highlights

Multiradar observations of transpolar ionospheric features

Highlight ID: 12617



Ionospheric electron density enhancement extending over the polar cap from the dayside to the nightside. Streamlines show the high latitude convection pattern.

Permission Granted
Credit: John Foster, MIT

By combining electron density meaasurements from incoherent scatter radars and ground-based Global Positioning System receivers, researchers at the Millstone Hill Observatory have shown that high latitude electron density features originate on the sunlit portion of Earth and are then transported into the nightside over the poles. The motion of the electron density enhancement is consistent with the direction of plasma flow as determined by a network of High Frequency radars called SuperDARN. The results show that electron density enhancments are produced on the dayside Earth by sunlight and then locally drawn into the polar regions by the convection electric field. After several hours the enhancement reaches across the entire polar cap, enabling it to be observed by incoherent scatter radars in Massachusetts, Greenland, and Norway. These observations confirm the origin of electron density enhancements commonly observed in the high-latitude nightside ionosphere. The results will be used by modelers to help improve and validate ionospheric models important for specifying and forecasting space weather. Ionospheric electron density enhancements can produce disruptions to navigation and communication systems.

Primary Goal Indicators:

- Contributions

Secondary Goal Indicators:

- Connections

This work is notable because:
The observations confirm the origin and evolution of high latitude electron density enhancements in the ionosphere.

Other Indicators (Is this work transformative or multidisciplinary?):

No other indicators apply.

GEO/ATM 2006

Program Officer: Robert Robinson

NSF Award Numbers:

0233230
Award Title: New Millenium Studies of Geospace with the Millstone Hill Observatory

PI Name: John Foster

Institution Name: Massachusetts Institute of Technology

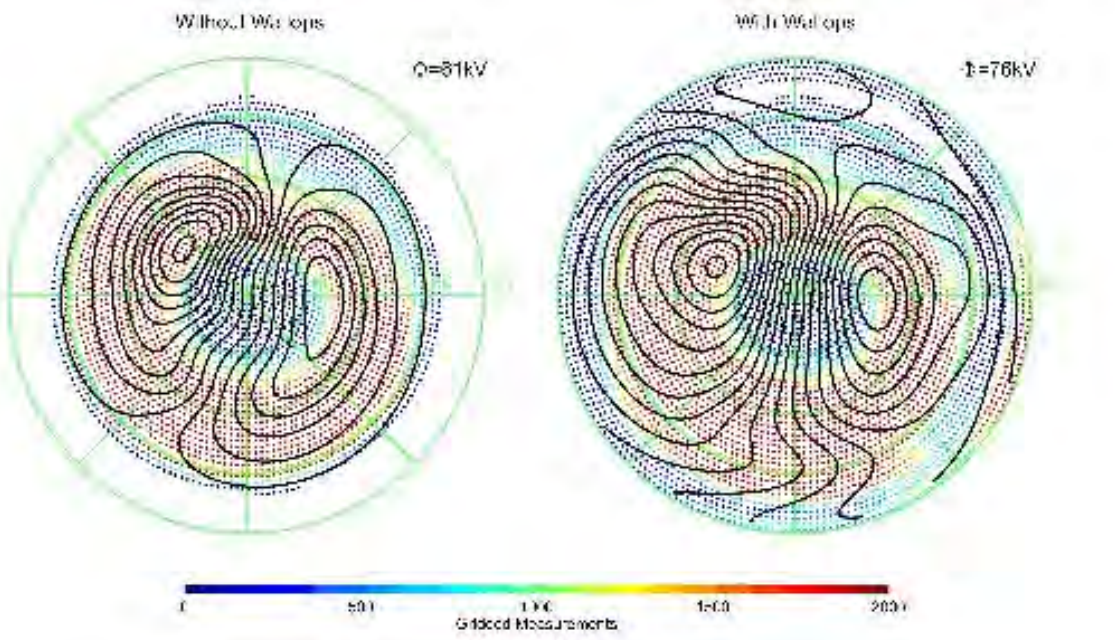
PE Code: 4202

Entered on 03/09/2006 by Robert M. Robinson

NSF Highlights

Improved Ionospheric Convection Maps

Highlight ID: 14245



Average SuperDARN ionospheric convection patterns calculated with (right) and without (left) data from the Wallops Island radar during periods of increased geomagnetic activity (*Kp* ³ 3). The contour spacing is 4kV; the cross-polar potential is provided at the upper right. Colored dots show how many gridded Doppler measurements contributed to the patterns at a given location according to the scale provided along the bottom. Important new features of the convection pattern are revealed by adding the mid-latitude measurements.

Credit: Joseph Baker, Johns Hopkins University

The solar wind transfers energy to Earth's magnetosphere and ionosphere by generating an electric field. The effects of this electric field are observed in the ionosphere as a large-scale convection pattern. During quiet times, the ionospheric convection pattern is confined to high latitudes, but during magnetic storms the polar cap expands, bringing the ionospheric convection – and the auroras – to much lower latitudes.

The premier facility for observing the ionospheric convection is the Super Dual Auroral Radar Network. In past, the SuperDARN radars were all located at relatively high latitudes and during magnetic storm conditions they suffered degradation of their measurements due to the increased absorption of the radar signal. In addition, much of the convection would move to lower latitudes than the radars could observe. To overcome these problems it was decided to construct a SuperDARN radar at a mid-latitude site, the NASA Wallops Flight Facility. This radar began operations in May 2005.

Recent work has examined the effect that the Wallops measurements have had on the determination of SuperDARN convection patterns. Average convection patterns have been calculated for the period June 2005 - April 2006 and binned by the *Kp* geomagnetic index. Even during weak to moderate geomagnetic activity (*Kp* ~ 3) the Wallops radar observes ionospheric irregularities between 50-60° magnetic latitude drifting westward across much of the nightside. When these measurements are incorporated into the calculation of an average SuperDARN convection pattern the streamlines of polar cap outflow on the nightside are significantly different from those calculated without the mid-latitude data. During increased geomagnetic activity (*Kp* > 3) Wallops is able to measure the expansion of auroral electric fields to middle latitudes and, as a result, SuperDARN measures total ionospheric electric fields 25% lrger than earlier measurements, showing that the energy transferred to the Earth from the solar wind is larger than previously estimated.

Primary Strategic Outcome Goal:

- Research Infrastructure: Build the nation's research capability through critical investments in advanced instrumentation, facilities, cyberinfrastructure and experimental tools.

Secondary Strategic Outcome Goals:

- Discovery: Foster research that will advance the frontiers of knowledge, emphasizing areas of greatest opportunity and potential benefit and establishing the nation as a global leader in fundamental and transformational science and engineering.

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
Extending the SuperDARN radar observations to mid-latitudes will provide both new and improved measurements of ionopsheric convection on a global basis. Ionospheric convection is driven by electric fields, which are a key indicator of coupling between Earth's atmospheric and the solar wind.

Does this highlight represent transformative research?
No

GEO/ATM 2007

Program Officer: Robert Robinson

NSF Award Numbers:

0418101

Award Title:	SuperDARN Radar Investigations of Global Processes in the High-Latitude Ionosphere: Infrastructure, Community Support, and Science
PI Name:	J. Michael Ruohoniemi
Institution Name:	Johns Hopkins University
PE Code:	4202

NSF Contract Numbers:

NSF Investments: None Applicable

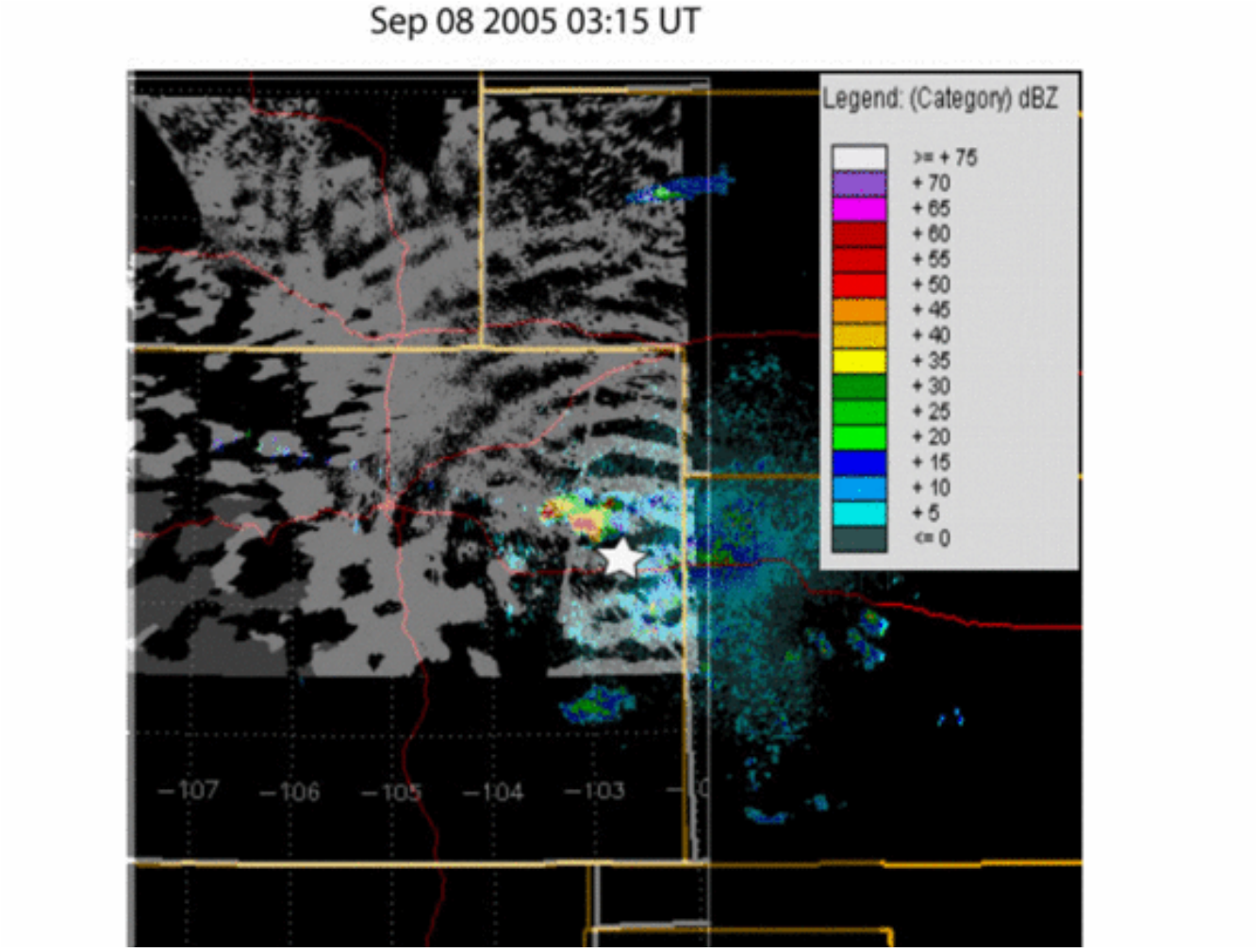
Related Center or Large Facility:

Submitted on 02/23/2007 by Robert M. Robinson
ATM: Approved 02/23/2007 by Richard A. Behnke
GEO: Approved 03/09/2007 by William M. Smith

NSF Highlights

Coupling of the lower and upper atmosphere

Highlight ID: 16592



Gravity waves observed in the upper atmosphere near 90 km over Colorado that were caused by a thunderstorm

Permission Granted
Credit: Steven Reising and Chiao-Yao She, Colorado State University

Atmospheric waves are prominent and ubiquitous features in the mesosphere and lower thermosphere, at altitudes of about 60 to 150 km. A particularly important feature of waves is that they carry energy and momentum from one region to another. The dynamics of the mesosphere and lower thermosphere, in fact, are largely controlled by waves.

Using an all-sky imager located at Yucca Ridge, Colorado and provided by Professor Yukihiro Nakamura of Kyoto University, researchers at Colorado State University observed a rare signature of a convectively-generated gravity wave at a height of 87 km. Professors Chiao-Yao She and Steven Reising, working with graduate student Jia Yue, correlated the images with a thunderstorm that occurred in the lower atmosphere, below 15 km altitude. Like ripples produced by a stone that strikes a pond, the gravity waves from the thunderstorm radiate outward from the source but they also propagate upward. Examination of observations over a period of time showed that these patterns can be observed only during the equinox periods of March/April or September/October when the horizontal east-west winds between 15 and 87 km are weak. The figure shows an observed gravity wave pattern (with the epicenter marked by a star) overlaid on a NEXRAD radar image of the associated thunderstorm in the troposphere separated by ~30 min, the time it takes the wave to propagate from 15 to 87 km altitude. These observations demonstrate the transient, direct coupling of energy from the troposphere to the mesosphere and lower thermosphere region, lasting on the order of several hours.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Graduate Education

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
The effects of gravity waves on the atmosphere is currently one of the most active areas of research in atmospheric sciences. A key element of the effort is the question of what causes gravity waves. A second major factor is determining how they propagate or move through the atmosphere. This work clearly shows that lower atmosphere pheonomena, such as thunderstorms, are able to penetrate the upper atmosphere, where they can influence the winds, temperature, and composition of this region. It is advancing our knowledge of the generation, propagation, and influence of gravity waves on the atmosphere

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science BoardEnhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

The research results were made possible by an international collaboration with a Japanese scientist and included the participation of a graduate student in the analysis and interpretation.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware?*If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

Understanding the coupling between the lower and upper atmosphere is key to understanding the physics and physical processes related to climate change and space weather.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0545221
Award Title: Collaborative Research: A Consortium of Resonance and Rayleigh Lidars
PI Name: Steven Reising
Institution Name: Colorado State University
PE Code: 4202

0335127
Award Title: CEDAR Postdoc: Seasonal Variations in Mesopause Region Temperatures, Zonal and Meridional Winds: Climatology and Variability of Mean-State, Diurnal and Semidiurnal Tides
PI Name: Chiao-Yao She
Institution Name: Colorado State University
PE Code: 1521

NSF Contract Numbers:

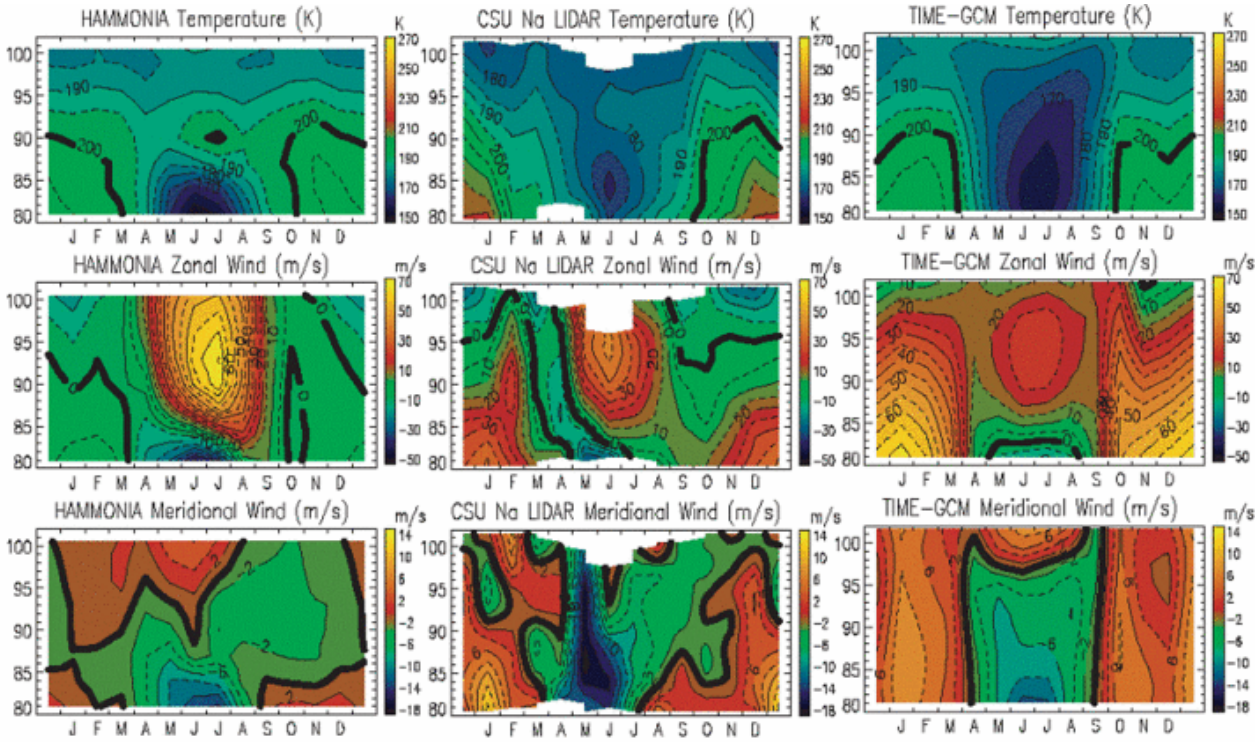
NSF Investments: None Applicable

Submitted on 02/28/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/06/2008 by William M. Smith

NSF Highlights

Middle Atmosphere Monthly Mean Temperatures and Winds

Highlight ID: 16633



The monthly mean temperatures and winds observed over Colorado derived from four years of observations. The middle row shows the observations, from 80 to 100 km, of the temperatures (top), the east-west winds (middle), and the north-south winds (bottom). The left and right panels show predictions from two theoretical models for the same conditions and location; the left column show simulations from the HAMMONIA model and the right column from the TIME-GCM. There are areas of good agreement between the data and models, but also areas of disagreement. Note that the two models do not always agree with each other.

Credit: Steven Reising and Chiao-Yao She, Colorado State University

Using a lidar, researchers at Colorado State University have assembled a unique dataset of winds and temperatures in the middle atmosphere. Observations have been obtained over four full years, with the observations covering the full 24-hour daily cycle of the winds and temperatures. Using these measurements, the team produced the first maps of the monthly means for the mesopause-region temperature and the horizontal winds in the east-west and north-south directions. The results provide an extensive reference climatology that will be useful in testing and developing theoretical models of the Earth's middle atmosphere.

These observations are particularly noteworthy since the Earth's middle atmosphere has long been one of the most challenging regions of the atmosphere to monitor and make observations. The altitudes are typically too high for weather balloons to study and too low for rockets and satellites to orbit. As a result, it has been difficult to establish even the "average" behavior of this region, such as what is the average temperature during June or how fast do the winds blow and do they change with the seasons?

Ground-based instruments have been used to monitor this region remotely, typically by using measurements of the nightglow, the natural emissions of the upper atmosphere constituents. Daytime observations were generally not possible since sunlight swamps the signal from the atmosphere. However, recent developments in lidar technology has enabled the making of measurements during both day and night, developments exploited by the Colorado State University researchers.

The figure shows a comparison between the lidar measurements, shown in the middle panel, and simulations from the models TIME-GCM (on the right) and HAMMONIA (on the left). Comparisons with the models of the upper atmosphere show general agreement, but there were also discrepancies between the observations and the model predictions, as well as differences among predictions from the different models which are being investigated by the researchers and the theoreticians.

Primary Strategic Outcome Goal:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

Secondary Strategic Outcome Goals:

- Research Resources and Tools (other than Cyberinfrastructure) (definition)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
This work has already advanced the frontiers of knowledge by delineating in detail the temperature and dynamics of the middle atmosphere over Colorado. Such

information is critically important for studies of the coupling between the lower and upper atmosphere, a topic of major interest and activity in the upper atmosphere research community. In order to carry out these observations, the researchers developed novel techniques, instruments, and analysis methods.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

No

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

Yes

The research team regularly includes graduate students and postdoctoral scholars in all facets of their research, from instrument development and adaptation to implementation, observation, and data analysis and interpretation.

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

This project provides the necessary background conditions for studies of coupling between the lower atmosphere and upper atmosphere. Understanding the coupling is key to understanding the processes involved in climate change and space weather which affects communications and navigation systems.

GEO/ATM 2008

Program Officer: cassandra fesen

NSF Award Numbers:

0545221
Award Title: Collaborative Research: A Consortium of Resonance and Rayleigh Lidars
PI Name: Steven Reising

Institution Name: Colorado State University

PE Code: 4202

0335127
Award Title: CEDAR Postdoc: Seasonal Variations in Mesopause Region Temperatures, Zonal and Meridional Winds: Climatology and Variability of Mean-State, Diurnal and Semidiurnal Tides
PI Name: Chiao-Yao She

Institution Name: Colorado State University

PE Code: 1521

NSF Contract Numbers:

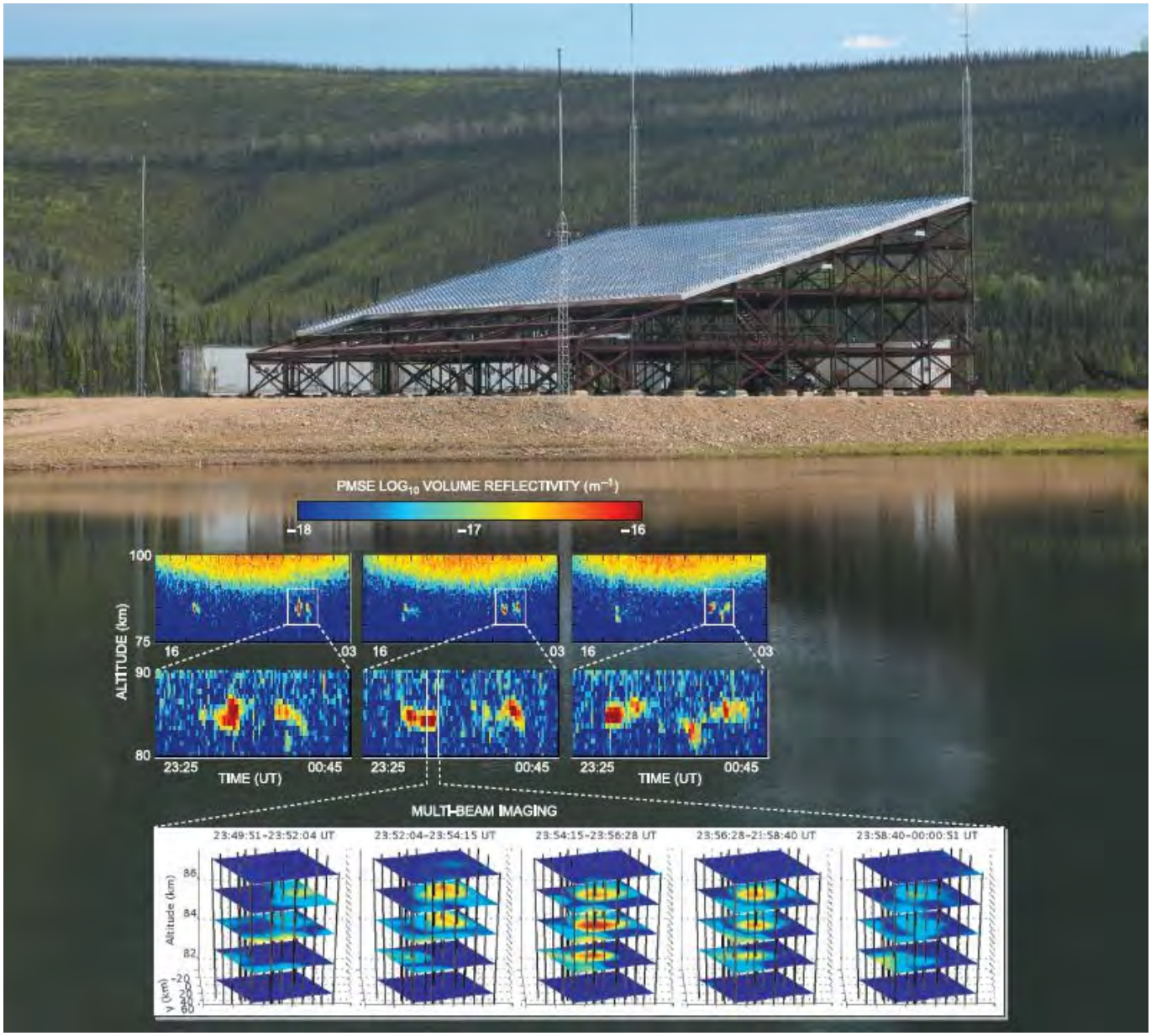
NSF Investments: None Applicable

Submitted on 02/28/2008 by Cassandra Fesen
ATM: Approved 03/05/2008 by Richard A. Behnke
GEO: Approved 03/06/2008 by William M. Smith

NSF Highlights

New Radar Observations from Poker Flat, Alaska

Highlight ID: 16637



The Poker Flat Incoherent Scatter Radar. Insets show radar backscatter from Polar Mesospheric Summer Echoes between 80 and 90 km altitude. The middle row focuses in on a region of interested. In the bottom, 25 beams (black lines) have been used to create the first three-dimensional images of these structures in the middle atmosphere.

The Poker Flat Incoherent Scatter Radar (PFISR) is a 450 MHz phased-array radar with solid-state components that allow for remote operation and versatile pulse-to-pulse beam steering. The ability to probe multiple volumes essentially simultaneously allows for the imaging of ionospheric structures such as Polar Mesosphere Summer Echoes (PMSE), which are associated with ice particles and Noctilucent Clouds (NLCs) that form in the mesopause region, the coldest place on Earth. PFISR represents a new era in incoherent scatter observations of the ionosphere. Its modular design will allow the radar to be disassembled and moved to other locations as scientific requirements demand. These early observations demonstrate the high sensitivity and excellent spatial and temporal resolution. The radar is being operated routinely throughout the International Polar Year to provide a synoptic data base important for studies of climate change and space weather.

Primary Strategic Outcome Goal:

- Major Multi-User Facilities (definition) (AC/GPA selected)

Secondary Strategic Outcome Goals:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
PFISR is a major new observational facility for upper atmospheric research. The data will be used by researchers world-wide and its ease of operation and remote access make it an excellent tool for training the next generation of radio scientists.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

This new technique for scientific incoherent scatter radars will pave the way for more such radars deployed and operated world-wide.

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

Incoherent scatter radar is the primary means by which space scientists observe and study the upper atmosphere and ionosphere. These observations are important for studies of space weather, climate change, plasma physics and radiowave technology.

GEO/ATM 2008

Program Officer: Robert Robinson

NSF Award Numbers:

0608577
Award Title: Advanced Modular Incoherent Scatter Radar (AMISR) Operations and Maintenance: The First Deployments
PI Name: John Kelly

Institution Name: SRI International

PE Code: 4202

NSF Contract Numbers:

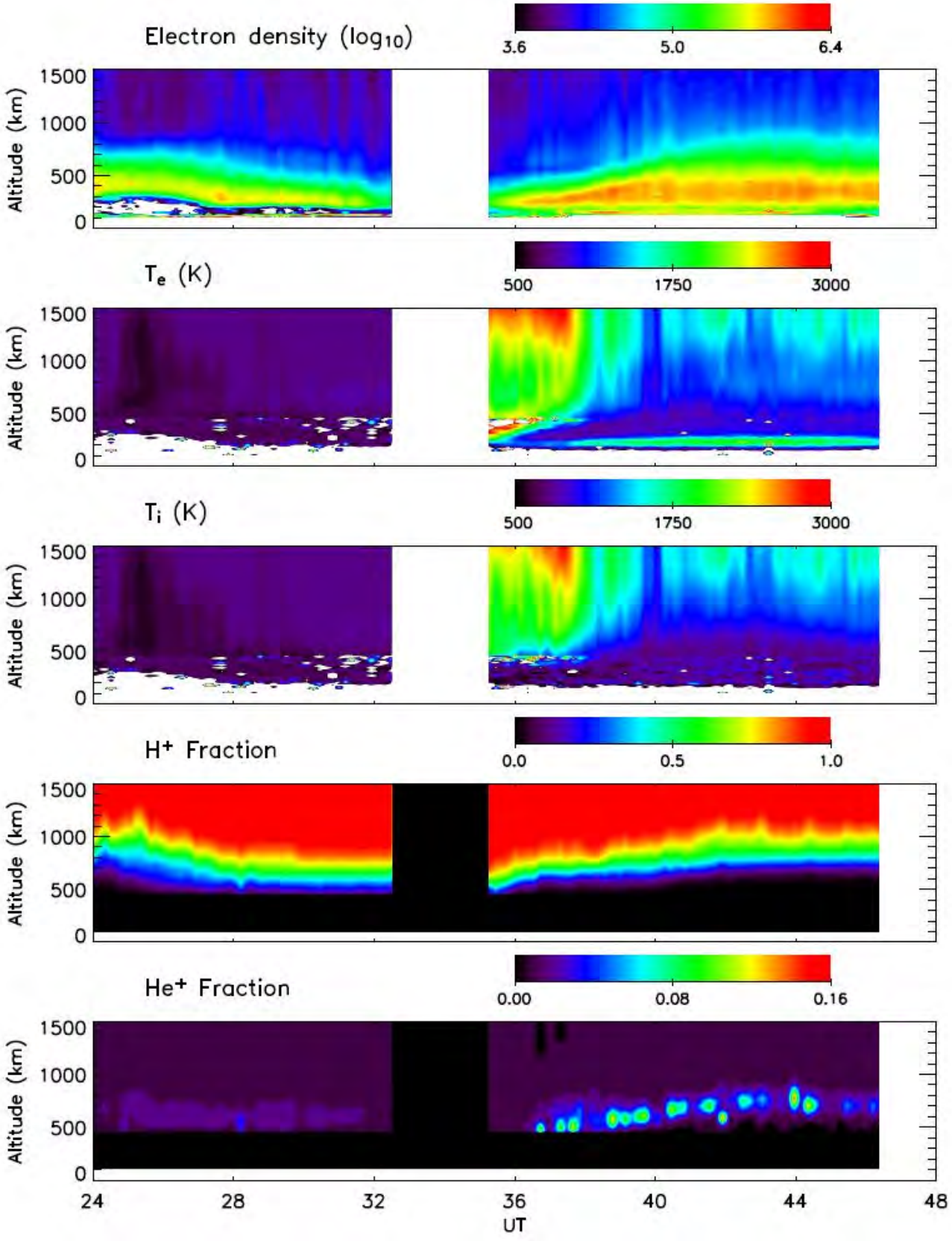
NSF Investments: International Polar Year (IPY)

Submitted on 03/03/2008 by Robert M. Robinson
ATM: Approved 03/07/2008 by Robert M. Robinson
GEO: Approved 03/11/2008 by William M. Smith

NSF Highlights

Comprehensive Measurements of the Equatorial Ionosphere

Highlight ID: 16661



The figure presents typical results from the full-profile analysis. From top to bottom, the panels represent electron density, electron temperature, ion temperature, hydrogen ion fraction, and helium ion fraction (18\% full scale). A data gap exists when the galaxy was directly over the radar. The data shown compare favorably with ionosphere models.

Permission Granted
Credit: David Hysell

A new technique implemented at the Jicamarca Radio Observatory allows unprecedented measurements of the height profile of properties of the ionosphere and thermosphere. Until now, the incoherent scatter radar technique has not been used at the equator because of ionospheric irregularities that swamp the weak signals from incoherent scattering. The new technique uses a combination long-pulse and double-pulse transmission and the return signals are analyzed using a full-profile analysis. With this technique, height profiles of plasma density, electron and ion temperatures, and light ion composition profiles in the topside are estimated simultaneously. Full-profile analysis is crucial at Jicamarca, since the properties of the ionospheric plasma prevent conventional range-by-range analysis. The analysis provides the first comprehensive assessment of ionospheric conditions over Jicamarca at sunrise as well as the first comprehensive record of helium ion layers. Recent improvements to the analysis methodology, which is rooted in statistical inverse theory, permit results to be provided in near real time.

Primary Strategic Outcome Goal:

- Major Multi-User Facilities (definition) (AC/GPA selected)

Secondary Strategic Outcome Goals:

- Disciplinary/Interdisciplinary Research (Anything not covered by one of the 12 categories below.)

How does this highlight address the strategic outcome goal(s) as described in the NSF Strategic Plan 2006-2011?:
Jicamarca is one of the most sensitive incoherent scatter radars in the world, but it has always been hampered by coherently scattered signals that prevent determination of many important ionospheric parameters. This new technique will be extremely useful for study the structure and behavior of the equatorial ionopsphere in unprecedented detail.

Does this highlight represent transformative research? *If so, please explain why.*
The National Science Board has defined transformative research as "Research that has the capacity to revolutionize existing fields, create new subfields, cause paradigm shifts, support discovery, and lead to radically new technologies." National Science Board: Enhancing Support of Transformative Research at the National Science Foundation

Yes

This operating mode will be routinely used at Jicamarca and will replace the outdated and limited operating modes used before. This data will be used by researchers for studying ionospheric phenomena at the equator that are still poorly understood.

Does this highlight represent Broadening Participation? *If so, please explain why.*
The concept of broadening participation includes: individuals from underrepresented groups, certain types of institutions of higher education, geographic areas (e.g. EPSCoR states), and organizations organizations whose memberships are composed of institutions or individuals underrepresented in STEM or whose primary focus is on broadening participation in science and engineering. It is important to note that underrepresented groups vary within scientific fields.

No

Are there any existing or potential societal benefits, including benefits to the U.S. economy, of this research of which you are aware? *If so, please describe in the space below.*
It is important for NSF to be able to provide examples of NSF-supported research that have or may have societal benefits.

Yes

This will lead to a better understanding of the equatorial ionosphere, which is the site of scintillations that can disrupt radiowave signals necessary for navigation and communication systems. This data will help validate models and theories used in predicting space weather effects at the equator.

GEO/ATM 2008

Program Officer: Robert Robinson

NSF Award Numbers:

0432565
Award Title: Next Millennium Research at the Jicamarca Radio Observatory

PI Name: David Hysell

Institution Name: Cornell University

PE Code: 4202

NSF Contract Numbers:

NSF Investments: None Applicable

Submitted on 03/03/2008 by Richard A. Behnke
ATM: Approved 03/07/2008 by Robert M. Robinson
GEO: Approved 03/11/2008 by William M. Smith