

CORE QUESTIONS and REPORT TEMPLATE
for
FY 2010 NSF COMMITTEE OF VISITOR (COV) REVIEWS

Guidance to NSF Staff: This document includes the FY 2010 set of Core Questions and the COV Report Template for use by NSF staff when preparing and conducting COVs during FY 2010. Specific guidance for NSF staff describing the COV review process is described in Subchapter 300-Committee of Visitors Reviews (NSF Manual 1, Section VIII) that can be obtained at <www.inside.nsf.gov/od/oia/cov>.

NSF relies on the judgment of external experts to maintain high standards of program management, to provide advice for continuous improvement of NSF performance, and to ensure openness to the research and education community served by the Foundation. Committee of Visitor (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 outcome goals.

Many of the Core Questions are derived from NSF performance goals and apply to the portfolio of activities represented in the program(s) under review. The program(s) under review may include several subactivities as well as NSF-wide activities. The directorate or division may instruct the COV to provide answers addressing a cluster or group of programs – a portfolio of activities integrated as a whole – or to provide answers specific to the subactivities of the program, with the latter requiring more time but providing more detailed information.

The Division or Directorate may choose to add questions relevant to the activities under review. NSF staff should work with the COV members in advance of the meeting to provide them with the report template, organized background materials, and to identify questions/goals that apply to the program(s) under review.

Suggested sources of information for COVs to consider are provided for each item. As indicated, a resource for NSF staff preparing data for COVs is the Enterprise Information System (EIS) –Web COV module, which can be accessed by NSF staff only at <http://budg-eis-01/eisportal/default.aspx>. In addition, NSF staff preparing for the COV should consider other sources of information, as appropriate for the programs under review.

Guidance to the COV: The COV report should provide a balanced assessment of NSF's performance in two primary areas: (A) the integrity and efficiency of the **processes** related to proposal review; and (B) the quality of the **results** of NSF's investments that appear over time. The COV also explores the relationships between award decisions and program/NSF-wide goals in order to determine the likelihood that the portfolio will lead to the desired results in the future. Discussions leading to answers for Part A of the Core Questions will require study of confidential material such as declined proposals and reviewer comments. *COV reports should not contain confidential material or specific information about declined proposals.* Discussions leading to answers for Part B of the Core Questions will involve study of non-confidential material such as results of NSF-funded projects. The reports generated by COVs are used in assessing agency progress in order to meet government-wide performance reporting requirements, and are made available to the public. Since material from COV reports is used in NSF performance reports, the COV report may be subject to an audit.

We encourage COV members to provide comments to NSF on how to improve in all areas, as well as suggestions for the COV process, format, and questions. For past COV reports, please see <http://www.nsf.gov/od/oia/activities/cov/covs.jsp>.

**FY 2010 REPORT TEMPLATE FOR
NSF COMMITTEES OF VISITORS (COVs)**

The table below should be completed by program staff.

Date of COV: April 7-9, 2010
Program/Cluster/Section: Atmosphere Section
Division: Division of Atmospheric and Geospace Sciences
Directorate: Geosciences
Number of actions reviewed: Provided: Atmospheric Chemistry-55, Climate and Large-Scale Dynamics-47, Paleoclimate-56, Physical and Dynamic Meteorology-51, Awards: 102 AWARDS Declinations: 46 DECLINES Other:
Total number of actions within Program/Cluster/Division during period under review: Awards: 617 Declinations: 617 Other: 2168
Manner in which reviewed actions were selected: COV review procedures: Met with Program Officers (POs) Received list of suggested proposals Discussions with POs. Reviews were checked for conflicts of interest. COV members requested additional jackets for: <ul style="list-style-type: none"> • Panel actions • RAPID & workshop/conference proposals Selected "outliers" were reviewed, looking at the highest DEC and lowest AWD by score Examined some MRI jackets Smaller number of jackets examined in greater detail for any significant common or systematic issues that arose

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.

<p>QUALITY AND EFFECTIVENESS OF MERIT REVIEW PROCESS</p>	<p>YES, NO, DATA NOT AVAILABLE, or NOT APPLICABLE¹</p>
<p>1. Are the review methods (for example, panel, ad hoc, site visits) appropriate?</p> <p>Comments:</p> <p>The Atmosphere Section (AS) employs a mix of mail reviews and panels, though the majority of the proposals submitted to the AS core programs received mail reviews. Panels were used by the P2C2 program, and are also employed elsewhere in the Section for certain special circumstances, usually (but not always) associated with a solicitation – e.g., field campaigns, inter-agency efforts, intra-NSF but inter-program efforts, or highly interdisciplinary initiatives. There are very occasional instances when a PO will ask another division to consider a proposal in one of its panels, to assess potential for cost sharing, and to get an interdisciplinary assessment. Site visits are used for Science and Technology Centers (STCs) (e.g., CMMAP) and similar entities. In general, there was a minimum of four ad hoc reviews per proposal throughout the Section.</p> <p>The panel process adds an important and different element to the review process, particularly because: 1) Panels are typically composed of more individuals, and these tend to be from research areas that are less closely aligned with the specific investigation, whereas the mail reviews are typically from three reviewers who are very closely (although not always) aligned with the research being proposed; 2) The panel summaries clearly offered different perspectives compared to the mail reviews in a number of cases, particularly in cases where the program decision to fund or decline differed from the overall reviewer. Cases of contrasts between ad hoc reviews and panel summaries raised a question: Why are panels not more often used in the core program?</p>	<p>YES</p>

¹ If “Not Applicable” please explain why in the “Comments” section.

<p>The POs were asked this directly, and in answering the question, acknowledged both the challenges and benefits of the panel system. The benefits are apparently outweighed in the routine handling of proposals that are accepted at any time, as occurs for the bulk of core program proposals. The COV is satisfied that the POs exercise appropriate judgment in balancing panels and ad hoc reviews and also appropriately revisit the arguments in favor of panels and ad hoc reviews.</p> <p>Some proposals by-passed peer review and were fast-tracked by the program managers (outside of the normal SGER/EAGER/RAPID process). These were generally small efforts tied to planned field campaigns. This seems like a good way to fund emerging ideas but the COV recommended that it should always be exercised with utmost integrity to avoid being over-used.</p> <p>.</p>	
<p>2. Are both merit review criteria addressed</p> <p>a) In individual reviews?</p> <p>b) In panel summaries?</p> <p>c) In Program Officer review analyses?</p> <p>Comments: Overall, a resounding “yes.” Significant attention is paid by the POs to recognize and document responsiveness to the merit review criteria. Both merit review criteria are addressed essentially universally in panel summaries and PO review analyses, and both play a significant role. In individual reviews they are treated more unevenly. The “Broader Impacts” criterion is the most problematic. While this criterion is addressed in the majority of individual reviews, it is typically done so with a much lower level of detail, and it does not seem to play a major role in rating. This was also noted in the previous COV report.</p> <p>Recommendation: The COV recommends that AS consider piloting the formation and use of a separate, standing pool of Broader Impacts reviewers with particular expertise in education, outreach, and knowledge transfer, as is done, for example, with STC site visit teams, to establish a consistent and high level of broader impacts review across all the AS proposals.</p> <p>There are recurrent examples of disparity among ad hoc reviews for particular proposals. Among the proposals reviewed here, it is not uncommon to have scores of Fair and Excellent for the same proposal. This constitutes a challenge to the PO, who must decipher the underlying reasons for this disparity and make a judgment that is fair and impartial. In this regard the POs have clearly done an excellent job of assessing the reasons for such disparity and have demonstrated appropriate consideration and evaluation that has resulted in appropriate decisions in all cases that were reviewed here.</p>	<p>YES</p> <p>YES</p> <p>YES</p>

<p>3. Do the individual reviewers provide substantive comments to explain their assessment of the proposals?</p> <p>The amount of information provided by individual reviews varies greatly. In general, however, the large majority of reviews provide substantive comments, and the collection of reviews for any given proposal appears to be sufficiently information-rich to provide the needed guidance to the PO (credit to the POs for making efforts to collect a sufficient pool of reviews). These substantive comments were critical in informing PO decisions, as numerous instances of mismatches (often subtle) between rating and collection of comments were noted. However, as noted previously, by far the most substantive comments were provided for Intellectual Merit compared to Broader Impacts.</p>	<p>YES</p>
<p>4. Do the panel summaries provide the rationale for the panel consensus (or reasons consensus was not reached)?</p> <p>Though panels are not widely used in AS, the occasions they are used the panel summaries are in general thoughtful, well crafted documents with critical information on the strengths and weaknesses of each proposal. The rationale for the consensus view represented in the panel summaries was in general well developed. This requires judgment from the panel member and the PO, as sometimes the external reviews provide a broader range of opinions.</p>	<p>YES</p>
<p>5. Does the documentation in the jacket provide the rationale for the award/decline decision?</p> <p>(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.)</p> <p>The documentation in the jacket provides a substantial rationale for the award/decline decision. Particularly strong are the review analyses of the POs, who almost unfailingly provide a thoughtful, nuanced synthesis of complicated and occasionally very divergent review information for the same proposal. The skill and attentiveness of the POs is impressive.</p>	<p>YES</p>

<p>6. Does the documentation to PI provide the rationale for the award/decline decision?</p> <p>(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.)</p> <p>Comments: Reviews are provided directly by request in FastLane. In cases where the PI was contacted by phone only, it is not possible to evaluate the level of feedback provided, except as recounted by the given PO in the review analysis, in diary notes, or during the COV review. For all jackets reviewed, this COV feels that the POs did an exemplary job of mentoring PIs to produce successful proposals in the future, especially for young investigators.</p>	<p>YES</p>
<p>7. Is the time to decision appropriate?</p> <p>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.</p> <p>Except where otherwise relaxed (e.g., FY09), the Section was able to meet its performance goals. The time to decision grew longer in 2009, but this can be attributed to the need to administer ARRA funding, which was a significant increase in workload. When the time to decision was longer, it was almost always because the PO was not clear on what internal, NSF funding decisions would be made, and thus held on to certain jackets to see what year-end funds might be forthcoming. The COV felt that this added flexibility was useful since it appeared, in many if not most cases, the extra time resulted in awards rather than declines.</p>	<p>YES</p>
<p>8. Additional comments on the quality and effectiveness of the program's use of merit review process.</p> <p>The process is fair, well-thought-out, and well-executed. The POs have some discretion in making decisions to award or decline – the reviews are one important component, but not the only one. It seems reasonable to the COV that if qualified people are placed in these positions they ought to have this discretion, and this COV is very impressed with the skill with which the POs carried out their decision-making.</p> <p>The POs might consider making additional site visits to see the PI's operations at their home institutions. The COV feels this could add an additional perspective that does not necessarily</p>	

emerge through the external or panel review process, but the COV recognizes that staffing and resources may not generally permit this.

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
<p>1. Did the program make use of reviewers having appropriate expertise and/or qualifications?</p> <p>The PO did use expertise from across a broad range of types of reviewers, e.g., from both junior and senior scientists, in evaluating proposals. Overall, the POs do an excellent job in securing reviewers with appropriate expertise and qualifications.</p>	YES
<p>2. Did the program use reviewers balanced with respect to characteristics such as geography, type of institution, and underrepresented groups?</p> <p>Note: Demographic data is self reported, with only about 25% of reviewers reporting this information.</p> <p>Comments:</p> <p>Reviewer demographics indicate that an appropriate balance of reviewers was used. Reviewers were drawn from every state, with more populous states, and states with a larger number of atmospheric scientists, appropriately providing larger percentages of reviewers. Reviewers came from a range of institutions, including 4-year colleges, government, foreign institutions, the private sector, PhD-granting institutions, and research-intensive PhD institutions. The latter provided the highest percentage of reviewers, as is to be expected. The reviewers reflect an appropriate balance of underrepresented groups, although the numbers of minorities are small: While this information may or may not be reported by a reviewer, in some cases the POs use their personal knowledge about the community of scientists, allowing them to make appropriate decisions about reviewers, and helping to ensure broad representation in the review process.</p>	YES
<p>3. Did the program recognize and resolve conflicts of interest when appropriate?</p> <p>Conflicts of interests seem to be largely considered and resolved during reviewer selection. In the few cases where a conflict was discovered during or after the</p>	YES

² If “Not Applicable” please explain why in the “Comments” section.

review process, these reviews were not considered in the decision. The COV found the level of documentation in this area was appropriate.	
-------------------------------------------------------------------------------------------------------------------------------------------	--

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 APPROPRIATE³, OR DATA NOT AVAILABLE
<p>1. Overall quality of the research and/or education projects supported by the program.</p> <p>Comments:</p> <p>The overall quality of the research and education projects supported by the program is excellent. In the judgment of the COV, the program has a very good balance of research and education throughout. Educational programs are strongly supported and virtually all proposals have strong educational components through the education of graduate students, the support of post-doctoral associates, or the involvement of undergraduates.</p>	APPROPRIATE
<p>2. Does the program portfolio promote the integration of research and education?</p> <p>Comments:</p> <p>NSF is relatively unique among federal science funding institutions in its sustained commitment (at all levels of the organization, including that of individual programs) to supporting and promoting education. Precisely defining the meaning of “integration of research and education,” and established a desirable level (scientifically? societal?) is not straightforward. Education has many aspects, including career development, as well as skill development. It would be helpful to have some statistics about various outcomes, e.g., how well the community of scientists has been doing at placing students in various positions, both academic and other professional positions.</p>	APPROPRIATE

³ If “Not Appropriate” please explain why in the “Comments” section.

<p>3. Are awards appropriate in size and duration for the scope of the projects?</p> <p>Comments:</p> <p>In general, yes. The POs have a great deal of discretion in establishing the size and duration of the awards they make. In our judgment, they use the experience they have gained to appropriately fine-tune their decisions about amount and timescale. Instances of revised scope and budget were well justified on scientific, budgetary or programmatic grounds, and often supported – or indeed, identified by – specific peer review input. Although there has been no formal target amount for awards, they seem to be well balanced in and among programs in AS, averaging around \$120-150K per year.</p>	<p>APPROPRIATE</p>
<p>4. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Innovative/potentially transformative projects? <p>Comments:</p> <p>The POs have some discretion in determining which proposals fall under the transformational research category, fast-tracking those in some instances (e.g., impending field efforts). The number of awards for risky or innovative projects appears balanced within the programs and is further evidenced in part by the number of SGER/EAGER and RAPID grants given.</p>	<p>APPROPRIATE</p>
<p>5. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Inter- and Multi- disciplinary projects? <p>Comments:</p> <p>Inter-/multi-disciplinarity may be hard to define. In our judgment, however, based on the information provided, AS seems to actively pursue opportunities to support research at the boundary between disciplines (e.g., oceanography-meteorology, meteorology-space science, land-atmosphere interactions, etc.). This is appropriate given the inherently interdisciplinary nature of many research areas (e.g., multi-decadal climate change). This support sometimes occurs entirely within AS, sometimes with one or more other programs within NSF, or sometimes in partnership with other agencies (e.g. NOAA, NASA).</p>	<p>APPROPRIATE</p>

<p>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?</p> <p>Comments:</p> <p>The COV finds the balance between types of awards is appropriate – i.e., there is a healthy diversity. Most awards are for individual projects, though collaborative research is still a significant fraction. The diligence and commitment of the POs and the Section leadership are definitely large drivers of this success.</p>	<p>APPROPRIATE</p>
<p>7. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Awards to new investigators? <p>Comments:</p> <p>The percentage of awards to new investigators is roughly 20%, a number that has been fairly consistent over time, and, in our view, represents an appropriate balance. AS awarded a number of CAREER grants during FY07-09. In addition, the COV noted several examples where the PO offered a small amount of standard funding or SGER/EAGER funding where appropriate to help promising new investigators develop new ideas into full proposals.</p>	<p>APPROPRIATE</p>
<p>8. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Geographical distribution of Principal Investigators? <p>Comments:</p> <p>The balance across the nation is not even, of course, because the distribution of institutions capable of supporting high-quality PIs is itself not even. Nevertheless, the large majority of U.S. states had AS grants in FY07-09.</p>	<p>APPROPRIATE</p>
<p>9. Does the program portfolio have an appropriate balance of:</p> <ul style="list-style-type: none"> • Institutional types? <p>Comments:</p> <p>AS funds research and educational initiatives primarily at top research institutions with large graduate programs, which seems appropriate. Some of the funding goes to primarily 4-year institutions, particular for educational activities. The COV encourages continued efforts to secure reviews from a broader range of institutional types, such as appropriate experts from industry, museums, non-profits, other federal entities, and other non-governmental organizations.</p>	<p>APPROPRIATE</p>

<p>10. Does the program portfolio have an appropriate balance:</p> <ul style="list-style-type: none"> • Across disciplines and sub-disciplines of the activity? <p>Comments:</p> <p>This appears to be a priority for AS, where cross-disciplinary and interdisciplinary ideas and proposals are proactively encouraged and appropriately supported. The large number of awards and the amount awarded for projects co-funded with other NSF programs speaks well of the interdisciplinary nature of research conducted in the Section. Most if not all of the major sub-disciplines appear to have at least some representation.</p> <p>The COV found that the Paleo Program has a broad interdisciplinary portfolio, both within Paleo and also extending to other Divisions, but there was not as much cross-disciplinary activity between Paleo and the other programs in AS. Some formal strategic planning process, as discussed in A.4 below, might help identify reasons for this and opportunities for additional collaboration.</p>	<p>APPROPRIATE</p>
<p>11. Does the program portfolio have appropriate participation of underrepresented groups?</p> <p>Comments:</p> <p>The POs are appropriately concerned about diversity in their awards. The proportion of female (roughly 10-15%) and minority (roughly 2-5%) PIs in AS is low. However, this reflects the present situation in earth and atmospheric sciences as a whole, a problem that goes far beyond AS. We are satisfied that AS takes seriously the issue of broadening participation. The COV is satisfied that the Section is firmly committed to diversity and engagement of underrepresented groups and that the POs are doing their best to attract minorities in all areas. However, NSF could take additional steps to support the POs in their efforts to do so.</p> <p>Recommendation: The COV recommends that NSF investigate ways to offer additional institutional support for developing pools of reviewers and potential PIs from currently underrepresented groups and for building relationships with these individuals.</p> <p>(We note that demographic data are not often available to the POs to assist in their decision-making about broadening participation in grants and the review process.)</p>	<p>APPROPRIATE</p>
<p>12. Is the program relevant to national priorities, agency mission, relevant fields and other constituent needs? Include citations of relevant external reports.</p>	<p>APPROPRIATE</p>

Comments:

AS research features prominently in the products of the IPCC, USGCRP (formerly CCSP), and the National Academies. AS is intrinsically linked to national priorities in weather, climate, and air quality. As the goals and objectives of the Paleo Program (including P2C2), CLD, and ATC are explicitly tied to the USGCRP, as well as to NSF's Geovision report, and the 2006-2011 Strategic Plan, these programs are indeed relevant to national priorities and the NSF's mission. Certainly, the types of studies conducted within the PDM program are needed to estimate the affect of climate change on local-to meso-scale weather phenomena, and to assess effects of these phenomena on issues of national interest such as commerce, transportation and agriculture.

The Section should be a 'Flagship' for NSF's contributions to the USGCRP. But other than the P2C2 endeavor we saw little evidence that the Section has a well-delineated implementation plan to contribute to the USGCRP via perhaps CCSP goals. When asked of the program officers how the section is contributing to this national effort. The philosophy seems to be that it is up to the community to submit proposals that would contribute to the USGCRP. There is a need for a strategic vision and planning. The COV recommends that the Section itself be more proactive in reaching out to the community in this regard.

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

The COV finds the overall quality and balance of the AS portfolio to be excellent. This COV echoes the comments of the previous COV, in that this is directly attributable to the quality of its POs and their ability to pay attention to, and address, both emerging and established needs of the program. We find the judgment and experience of the POs ensures a high-quality and balanced portfolio. That individual reviewers do not always agree, computers cannot evaluate risk, and science is driven in large part by individual initiative and grass-roots efforts, speaks to the need for this element in decision-making. There are many instances in the material the COV reviewed where the wisdom and experience of the PO in making tough decisions led to positive results.

In addition, the COV notes the initiative and imagination demonstrated by the Paleo PO in supporting a number of Broader Impacts efforts, such as the awards to the American Meteorological Society and to the Metcalf Institute. These are outstanding examples of bringing scientific results to a broad, influential audience.

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

1. Management of the program.

Comments:

Echoing the impressions of the previous COV, this COV was extremely impressed with the management and leadership of the POs in their individual programs, a function of their expertise, judgment, diligence, attention to detail, and initiative in responding to opportunities to fund excellent science, seeking the highest quality review for this science, and seeking partnerships within and outside NSF to leverage the impact of their programs. At the Section level, AS functions smoothly, with a high degree of collegiality. The COV here simply commends the POs for their excellent work and reiterates that they continue to play a critical role in keeping U.S. scientific enterprise vibrant and healthy.

As with the previous COV, there was concern with the gap in staffing during periods of transition of rotating staff. In addition, while the COV fully recognizes the benefit of IPAs bringing fresh ideas and an evolving sense of the community into each program, this must be balanced against the continuity, institutional memory, and accrued experience that can only be achieved with full-time NSF POs.

Recommendation: The COV recommends that each program establish a policy of having at least one full-time PO and one IPA at all times, to achieve this balance and ease transitions.

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

Comments:

Emerging research and education opportunities are fundamentally brought to the attention of the programs by the research community, but AS makes good use of a number of mechanisms to capitalize on these opportunities, including major field campaigns and SGER, EAGER, RAPID, REU, and CAREER grants. A number of innovative and potentially groundbreaking projects received encouragement and support from the Section, as described in more detail in part B, below. The COV also notes, however, that the ability to respond swiftly and adequately depends on budget constraints.

Responsiveness to emerging opportunities that cross disciplinary lines might be enhanced with more attention to Section-level strategic planning, as described in more detail in #3 below.

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

Comments:

As noted by the previous COV, as well as in the NRC report, "Strategic Guidance for the National Science Foundation's Support of the Atmospheric Sciences" (2007, page 66), this COV notes that the Paleo budget is conspicuously low when compared to the budgets of the other programs. In an environment of essentially constant percentage increases, such as was the case in FY07-09, this disparity will only continue to grow.

Recommendation: The COV is not in a position to comment on the appropriateness of the size of the budgets within the AS programs. However, the COV recommends that AS establish a formal strategic planning process to transparently establish and justify the basis for the future budget trajectories of each of the programs within the Section.

As discussed in #1 above, the AS programs are extremely well managed, and the POs are entrepreneurial in seeking opportunities for collaboration both within, and outside of, the Section (e.g., the success of the Paleo PO in convincing POs in other parts of Geosciences to pool funds and create an integrative program, P2C2). However, discussions during the COV review made clear that there is no formal process for joint strategic planning across the four programs. The COV feels that such a process would be helpful in a number of ways: e.g., to establish and justify budget trajectories (as noted above), to identify additional opportunities for collaboration across the programs (e.g., between Paleo and CLD in the area of multi-decadal dynamical variability in the atmosphere and ocean), and to link up even better with evolving top-down priorities (e.g., NSF-wide, national).

Recommendation: The COV recommends that AS establish a formal strategic planning process across the four programs in the Section and the Section leadership. This process would explicitly address issues including future budget trajectories of the program, inter-program collaboration, mapping the Section scientific priorities onto higher-level strategic plans at NSF and the U.S. government as a whole, identifying and seizing emerging opportunities, and articulation of a shared “Section identity.” This process would be aided by a number of mechanisms, including meetings, retreats, and a written strategic plan.

This COV concurs with the recommendation of the previous COV that additional, quantitative metrics and measures of success of AS outcomes may be very valuable in aiding planning and prioritization, despite the difficulty in establishing them.

Recommendation: The COV recommends that AS establish and track additional, quantitative outcome metrics for Discovery, Learning, and Research Infrastructure and use this tracking information to aid in planning and prioritization. Such metrics might include outcomes such as papers published, the numbers of undergraduates, master and graduate students and Post Docs funded through grants, student tracking (graduation of students on projects and their subsequent job histories), availability of gathered data sets, basis for subsequent proposal activity, number of proposals that explicitly target NSF’s USGCRP objectives, number of conference presentations, number of patents, etc.

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

Comments:

The COV finds a lack of response to the disparity in program funding allocations and the way in which this disparity is being considered by the Section. This was brought up previously by past COVs.

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: There is a valuable mix of projects within AS that has stimulated innovative collaborations across disciplines and involves cutting-edge science. There are abundant examples of important research discoveries/elements that have arisen from AS funding. Examples of these discovery award highlights identified by the COV or the four AS programs are listed below. Based on these awards and other past and current awards, the expectations for future progress are high, provided that funding is adequate. AS is supporting fundamental research that has great potential benefits to society through improved understanding and prediction of earth's atmosphere and climate.

1) Atmospheric Chemistry

The NSF made significant investments in a large, multi-agency international field mission that is still producing excellent science return. The Megacity Initiative: Local and Global Research Observations (MILAGRO) campaign was conducted in Mexico City during 2006. Two example MILAGRO science highlights from projects supported by the Atmospheric Chemistry Program follow.

Multiple groups, lead by Jose Jimenez (University of Colorado at Boulder) have used observations from the Aerodyne aerosol mass spectrometer to find commonalities regarding composition and aging of organic particulate matter (OA) around the world. These data were used to develop a unifying model framework that captures the dynamic aging behavior observed in both the atmosphere and laboratory and will serve as a basis for improving parameterizations in regional and global models. This work was recently published in Jimenez et al.(2009), *Science* **326**, 1525-1529. This study involved a large number of investigators, many of whom were supported by NSF (ATM-0840673, ATM-0449815, ATM-0513116, ATM-0528634). Data acquired during the MILAGRO campaign were central to the work.

Joost deGouw and colleagues at the University of Colorado at Boulder measured a variety of atmospheric trace gases with high time resolution at a suburban ground site in Mexico City during March, 2006 (ATM-0516610 “New Mass Spectrometer Technology for Analysis of Biogenic Volatile Organic Compounds (VOCs)”) and found there is far more reactive organic material emitted per carbon monoxide molecule than in the United States. This has important implications for the production of gaseous and particulate secondary pollutants that reduce air quality, impair human health and affect climate. The sources and sinks of volatile organic compounds in the ambient atmosphere are in general still poorly understood. In large urban areas, emissions from vehicles are well-documented, but explain only part of the measured levels of such compounds.

An additional science highlight of work supported by the Atmospheric Chemistry Program involves Joel Thornton (University of Washington) and colleagues who have made groundbreaking observations of nitryl chloride formation in continental regions using chemical ionization mass spectrometry (CIMS) (ATM 0633897, ATM 0846183). Nitryl chloride is a precursor to atomic chlorine, a powerful photochemical oxidant. It was previously believed that chlorine activation occurred only in coastal regions. Comparison of these findings to model predictions suggests nitryl chloride production in the continental USA alone is at a level similar to previous global estimates for coastal and marine regions. This work was recently published in Thornton et al. (2010), *Nature* 464, 271-274).

2.) Climate and Large Scale Dynamics

Climate and Large Scale Dynamics has been responsible for supporting a rich portfolio of truly significant research. This significance derives from both the achievement of fundamental scientific advances and the societal relevance of the resulting findings, as demonstrated by new insights and new applications. Many of these achievements have resulted from a novel integration of disciplines and/or of theory, observations, and modeling.

A few highlights:

Scientific and public interest in climate system processes and climate change (natural and anthropogenic) only continues to grow. CLD has supported several projects in FY07-09 that simultaneously improve our understanding of important couplings in the climate system and our ability to capture these interactions realistically in models. These include, for example: (i) Research

that has discovered a surprisingly important link between the treatment of snow albedo in climate models and the overall level of climate feedback simulated, adding an important dimension to our understanding of climate feedbacks; (ii) Research that has discovered similarly under-considered but potentially important feedbacks between terrestrial biophysical processes and climate feedbacks. CLD has also begun to support fundamental scientific research into the processes and feedbacks (and unintended consequences) that might be associated with various scenarios of geoengineering strategies. In addition, CLD is helping to bring about major advances in our understanding of the interactions between clouds and radiative and dynamical processes in the atmosphere, our ability to accurately represent these interactions in climate models, and the implications for our understanding of climate variability and change through the next generation of models and research at the Center for Multi-Scale Modeling of Atmospheric Processes (CMMAP) Science and Technology Center (STC).

CLD also continues to make possible the ongoing expansion of the frontiers of hurricane research. Recent findings from a project to improve our understanding of the basic science of global hurricane development and intensification suggest that the link between warmer ocean temperatures (and hence, potentially, anthropogenic climate change) and hurricane frequency may not be as straightforward as until very recently supposed. Instead, this ocean warming could lead to fewer hurricanes worldwide, as a result of warming-induced increases in vertical wind shear, a major advance in the theory.

Furthermore, CLD is at the forefront of research into modes of variability in the atmosphere, such as El Niño, and the implications of improved understanding of these modes for forecasting on seasonal (and longer) timescales, as well as for our understanding of future climate change.

CLD has supported a broad range of presumably “high risk/high reward” research through roughly a dozen Small Grants for Exploratory Research (SGER)/Early-Concept Grants for Exploratory Research (EAGER) awards.

Finally, theoretical advances made possible through CLD support have led to a suite of novel and potentially transformational measurement technologies (e.g., using GPS, cosmic rays, isotopes of water vapor) that we expect will lead to important new scientific advances and societal benefits. We discuss these in greater detail in our response to B.3 below.

3.) Paleoclimate

By its very nature, the Earth’s climate system is a complex system of interacting elements that operate on a wide range of spatial and temporal scales. The Paleoclimate Program is particularly valuable to the NSF’s AS because it extends climate research both temporally and spatially. The breadth of endeavors and the interdisciplinary nature of the program’s supported research are illustrated in the examples below, which includes examples from the P2C2. IPCC IR4 report had a dedicated chapter on paleoclimate science, and the P2C2 has advanced the work in this regard.

Several Illustrative Highlights:

1. 0902882 Co-funded with OCE

Award Title: Collaborative Research: Integrating proxies and Earth System Models to elucidate water cycle dynamics: Did global warming cause an enhanced hydrological cycle in the Eocene?
PIs: M. Huber (Purdue U) / M. Pagani (Yale U)

Research combining paleoclimate and instrumental observations with a new Earth system Model of Intermediate Complexity (EMIC) improves constraints on key climate parameters including those governing dynamical and potentially abrupt responses to forcing. Specifically, the research team will focus on dynamical mechanisms associated with the El Niño/Southern Oscillation (ENSO) and the Atlantic Meridional Overturning Circulation (AMOC) using an existing EMIC ("LOVECLIM").

2. 0630178

Award Title: Collaborative Research: SGER: Ice Core Paleoclimate Record from Mt. Waddington, British Columbia Coast Range

PI: Eric Steig

3. 0629497

Award Title: Collaborative Research: SGER: Ice Core Paleoclimate Record from Mt. Waddington, British Columbia Coast Range

PI: Douglas Clark

The team used a novel ice drill to recover an unexpected and unprecedented length (i.e., several hundred years to more than a millennium) record of climate from an alpine glacier atop Mt. Waddington in the British Columbia Coast Range. Three elements make this research transformative: 1) development of a novel ice core drill that is effective, mobile, and inexpensive; 2) successful deployment of the equipment in a location that yielded a surprisingly long millennial-length record of climate; and 3) continued exploration of a new paleoclimate archive previously out of reach of researchers.

4. 0602395

Award Title: Collaborative Research: Project PALEOVAR -- Past Climate Variability: Understanding Mechanisms and Interactions with the Mean State

PI: Nicklas Piasias,

A warming world has led to much study and speculation about the fate of the West Antarctic Ice Sheet (WAIS). The 2007 report of the Intergovernmental Panel on Climate Change (IPCC) notes that a full collapse of the WAIS would lead to a sea-level rise of around 5 m. However, studies have shown that sea levels would not rise evenly across the globe, due to the reduction of the gravitational attraction of the ice sheet itself. Dr. Peter Clark of Oregon St. University, in collaboration with Canadian colleagues, have improved the estimates of this phenomena, and have found that some areas, such as coastal North America, would experience 30% higher sea level rises than the assumption of an even distribution. In this NSF supported work, the researchers were able to incorporate shoreline mitigation and feedback associated with Earth's rotation to simulate sea level rise. The result of the simulation for Washington DC was a 6.3 m sea level rise, far above the IPCC assumption.

5. 0728315

Award Title: Ocean Circulation, Oxygen and Nutrient Cycles During the Last Glacial Period

PI: Andreas Schmittner

Research is revealing that ocean circulation plays a major role in controlling greenhouse gas fluctuations during glaciations. Among the "Grand Challenges" in Climate Science is understanding what processes regulate the systematic variations in atmospheric greenhouse gases, particularly CO₂, on glacial/interglacial time scales. This NSF-funded climate study is advancing modeling efforts to assess the role that ocean circulation changes play in driving carbon dioxide and nitrous oxide fluctuations during glacial periods on millennial time scales.

6. 0903020 (Co-funded with OCE-lead):

Award Title: Collaborative Research: Decadal Scale Patterns in Hurricane Activity Over the Last Several Millennia: Exploring Geographic Patterns and Climatic Forcing

PIs: J. Donnelly (WHOI) / J. Woodruff (U Mass, Amherst)

Improving understanding of long-term trends in hurricane landfall statistics is important for understanding the socioeconomic impacts of hurricanes and future projections. Previous studies from Puerto Rico suggested specific trends in hurricane frequency, e.g., an increase in hurricane landfall during the past 300 years. With NSF support the PIs are using high-sedimentation rate cores from coastal back-barrier ponds and sink holes at three different sites on Cape Cod, Massachusetts, Apalachee Bay, Florida, and Grenada in the Caribbean to reconstruct a late Holocene hurricane frequency record. They will also use storm-surge models to examine the significance spatial and temporal patterns in hurricane-induced deposition and test potential climate forcing.

4.) Physical and Dynamic Meteorology:

The variety of topics funded under this program is quite amazing, spanning topics in cloud physics and dynamics, boundary layer processes, instrumentation, and more. There are some particular highlights to note, which are described in more detail below.

The big splash, of course, was VORTEX-2, which was held over from the originally-planned 2006 campaign to eight weeks in spring/summer 2009. This will be followed up by a condensed, six-week field effort in 2010. VORTEX-2 brought investigators together to study the vexing problem of tornadogenesis: why, in what appear to be similar if not identical conditions, do some storms produce tornadoes and others do not? Are the differences observable? Can these observations lead to improved forecasts, especially a decrease in false alarms? Even within this relatively narrow field of focus there was a variety of embedded topics. A fleet of mobile radars (Frasier, U. Mass. Amhurst; Weiss, Texas Tech. U.; Knupp, UAH; Wurman, CSWR; Biggerstaff, OU; Bluestein, OU) was continually on the move. Other movable instruments included “upsondes” (Parker, NCU) and surface weather stations (Haan). The Situations Awareness for Severe Storms Intercept (SASSI) display developed by Rasmussen (Rasmussen Systems, LLC) was used to guide the investigators and their instrumentation to locations with potential for storms, yet with an ample safety margin. Stensrud (OU) will conduct further modeling studies using ensemble techniques. However, Mother Nature decided not to participate: only one tornado was actually observed, a weak one in Wyoming. Thus, the second year may be pivotal in providing much-needed additional cases. The funded proposals totaled more than \$5M and the question may well be asked: was it worth it? The program was timely in that it focused expertise and new instrumentation on a very narrow topic. The program was also risky in that tornadoes are somewhat rare events and as any field researcher knows, you're always at the mercy of the weather. However, it must be said that a valuable set of measurements on thunderstorm structure and precursors to storm formation was obtained.

Turning to winter weather concerns, just over \$1M was awarded to UIUC and UAH during this review period to support the PLOWS (Profiling of Winter Storms) field effort which took place in FY10 (November 2009 through February 2010). This ambitious program was motivated by the high number of fatalities and monetary costs associated with poor road conditions due to winter storms. PLOWS is targeted at understanding the dynamic and microphysical processes that govern the spatial and temporal variability of precipitation within extratropical cyclones. In PLOWS, Rauber (UIUC) and Knupp (UAH) proposed to obtain and analyze detailed, high-resolution observations of precipitation substructures using four mobile ground-based observing systems, the University of Alabama at Huntsville Mobile Integrated Profiling System, the Mobile Alabama X-band dual polarization radar, the NCAR Mobile Integrated Sounding System, and the University of Missouri sounding system, along with the NCAR C-130 Aircraft equipped with microphysical probes and the

Wyoming Cloud Doppler Radar and Cloud Lidar. PLOWS also includes simulation studies of precipitation substructures using the Weather Research and Forecasting Model at high horizontal and vertical resolution. Studies of winter storms are certainly nothing new. However, the methods used with new instruments, and the application to road weather forecasting, are novel and should further our knowledge of precipitation formation and distribution.

Lightning and electrification enjoyed strong support during this review period. Nearly \$2.7M of funds was committed to projects including Rakov's (University of Florida) study of the electromagnetic environment and source parameters. In this project, lightning was artificially initiated from natural clouds using a rocket-and-wire technique. The new experimental data show that, contrary to what was previously thought, the nitrogen oxide production is primarily from long-duration, steady currents, as opposed to short-scale impulsive return stroke currents. This implies that intracloud flashes are more efficient than ground flashes in generating nitrogen oxide. The Mt. Redoubt eruption in 2009 provided Thomas (NMIST) an opportunity to study lightning in a volcanic plume. From the data collected, the researchers found that the amount of lightning increases with plume height and that the flashes grew larger but their rate decreased as the eruption continued. Cummer (Duke University) captured in high-speed photos "gigantic jets", highly-charged lightning discharges emanating from the tops of storms. These rare events give a glimpse into processes in the Earth's global electrical circuit.

Four EAGER and SGER grants were awarded; these are specifically targeted toward exploratory research. Renno (PA State U. at University Park) is developing a prototype system for electrical and meteorological measurements in convective vortices; Kliche (SD School of Mines and Tech) is undertaking preliminary work for the development of the T-28 replacement; Hallett (DRI) is exploring the origin of dry lightning, common in desert areas and Eosco (AMS) is studying visual communication in the sciences. These represent good initial investments in new approaches for the future.

Overall the portfolio is broad and has high potential for expanding the frontiers of knowledge in physical and dynamic meteorology.

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

1.) Atmospheric Chemistry

Communicating science results and increasing science literacy are major goals of the NSF. HIAPER Pole-to-Pole Observations (HIPPO) is an experiment using the NSF/NCAR G-V aircraft in a circuit from Pole to Pole over the Pacific Ocean to measure atmospheric constituents that have a key role in climate, such as carbon dioxide and methane, to see how they vary geographically and by season. The HIPPO II Education and Outreach Program Team was led by Steve Wofsy of Harvard University under NSF support (ATM-0617232), and consisted of the principal investigators for the field campaign, the Earth Observing Laboratory (EOL) at the National Center for Atmospheric Research (NCAR), and various local and international education institutions. In an innovative and highly engaging approach to global education and outreach, creative use of social media and networking achieved broad dissemination of informative aspects pertaining to the chemistry of the atmosphere and global climate variability to the global community. Updates about HIPPO were posted on Facebook and Twitter pages, and videos about the campaign and science involved were posted on a special HIPPO You Tube channel. The result was to enhance the visibility of the campaign to the public, and spark the enthusiasm of students at all levels as well as the general public.

In the spring of 2008, Scot Martin from Harvard University lead a field campaign to study biogenic

secondary organic aerosols (SOA) in the Amazon rainforest. The campaign was a large international collaboration of researchers from the US, Europe, and Brazil; the US team was funded by ATC (ATM-0723582). The goal of the experiment was to characterize the formation, processing and cloud forming properties of natural secondary organic aerosols (SOA) in a pristine setting. The team measured aerosol loading, size distributions, composition using a high (mass) resolution time-of-flight aerosol mass spectrometer (HR ToF-AMS), particle fluxes, optical properties, cloud nucleation ability, and ice nucleation. A number of exciting results have emerged from this dataset, such as (1) the variability in the CCN activity of submicron particles during the campaign can be explained by diameter and by use of an effective hygroscopicity of mixing based on an organic parameter and a sulfate parameter; the organic parameter has the same value as obtained for SOA particles in laboratory experiments (Gunthe et al. (2009), *Atmos. Chem. Phys.* (9) 7551-7575). (2) A major source of ice nuclei in the wet season of the Amazon is transcontinental transport of Saharan dust; a local source of biological particles also contributes to the IN population, likely dominating at warmer temperatures where ice initiation occurs more frequently (Prenni et al. (2009), *Nat. Geosci.* (2) 402-405). Besides providing insight into particle formation and properties in the Amazon, this work advances our fundamental understanding of the connections between aerosol microphysics and aerosol chemical composition.

2.) Climate and Large-Scale Dynamics

We have found numerous examples where CLD support has led, or is expected to lead to, greater educational development of the scientific workforce and greater scientific outreach to the public. CLD of course makes a large investment in support of graduate student training, as well as targeted efforts to deliver educational opportunities to undergraduates.

A few highlights:

The Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC) hosts summer workshops in Taiwan and the United States to introduce graduate students to the science behind COSMIC and the application of COSMIC data.

The VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS) has developed a number of outreach initiatives, for example through UCAR's Windows to the Universe.

The already mentioned CMMAP STC has developed a truly impressive array of interlocking educational activities covering K-12 science education, undergraduate research opportunities, graduate student training in both research and teaching, and engagement of the campus community at Colorado State University in seminars, discussions, and cross-cutting activities relating to climate change and CMMAP research.

CLD has developed a number of mechanisms to support the participation of otherwise unfunded students in meetings and conferences, which we feel have a very significant educational benefit for a relatively modest financial investment.

Other notable activities:

- 1 Research in Undergraduate Institutions (RUI) award to Coastal Carolina University to investigate gravity waves and the polar stratosphere;
- 2 Research Experience for Undergraduates (REU) awards to the City University of New York and Hampton University;
- A post-doctoral program for climate and earth system modeling;
- 4 CAREER awards in areas including tropical easterly wave dynamics, the Hadley

circulation, the impact of land-atmosphere interactions on the Indian Monsoon, and the role of the hydrologic cycle in maintaining the atmospheric circulation.

3.) Paleoclimate

Looking forward to the 21st century, there is a growing need to build a strong community of well-educated atmospheric scientists to assume leadership positions outside of the academic setting. One excellent example of progress towards this goal was the award to William Hooke (0834225 and 0910744) to support the American Meteorological Society's summer policy colloquia, which bring up to 50 participants per year to Washington, DC for an intense, 10-day immersion in atmospheric science policy. These awards enabled the colloquia to run for over 8 years, providing a significantly enriching experience for over 400 individuals. Another example is the award to Paul Higgins and Anthony Socci (0939980) for the Charles Keeling Memorial Climate-Related Science and Policy Workshops. And finally, the award to Sara Hickox and Jackleen de la Harpe (0433415) of the Metcalf Institute funds a workshop series to improve communication on scientific matters through the media.

Regarding development of world-class scientists, the COV notes that recipients of Paleoclimate Program awards have been recognized for their excellence in science as demonstrated by the awarding of the MacArthur "Genius" prize to Dan Schrag and Peter Huybers and the National Medal of Science to Lonnie Thompson.

4.) Physical and Dynamic Meteorology:

Major, peer-selected awards covered a variety of topics; samples are described in detail here. Note that some are specific CAREER awards, and others represent educational activities embedded within the research award. PDM awards have led to tremendous efforts in developing educational and outreach activities in science and technology for undergraduate and graduate students, and even for K-12 students and teachers. PDM also strives to encourage awardees to train and maintain a workforce that reflects the rich diversity in students.

Noteworthy Learning Achievements Based on NSF awards:

VORTEX2 is expected to lead to further improvements in tornado warning skill. Through this project, VORTEX2 media was developed to provide a wide range of resources (digital image library and multimedia resources) for public uses (outreach and education) and training activities. In addition, the field phase of VORTEX2 provides numerous opportunities for student participation and has a potential to achieve the outcome goals for learning. For example, Christopher Weiss at Texas Tech University involves a large amount of graduate and undergraduate students in the planning and execution of field work, particularly those of Hispanic origin.

Zhien Wang at the University of Wyoming has a CAREER award which has a few components to enhance the atmospheric observation curriculum and teaching. He will update two courses: meteorological instrumentation (graduate level) and atmospheric remote sensing (graduate and undergraduate level). For the meteorological instrumentation course, a specific section of airborne instrumentation will be included and a website will be designed to make the course material available to the public.

Sukanta Basu at Texas Tech University has a CAREER Award, aiming to develop, evaluate and

improve low-level jet representations in large-eddy and mesoscale models. Collaborative efforts with the Shallowater Independent School District will be made to educate K-12 about wind energy as a renewable energy through expansion of K-12 science curriculum, development of web-based teaching module for K-12 students, classroom activities, field trip, and a 'Science Day' at the American Wind Power Center and Museum. Also, the PI will develop a new graduate course entitled "Wind Energy Meteorology" at Texas Tech and provides a summer internship program for graduate students.

Fotini Chow, University of California at Berkeley, creates a universal large eddy simulation (LES) framework in her CAREER award. This framework will be used together with observational data analysis to study terrain-induced flow features such as mountain waves and rotors and valley wind circulations. The educational and outreach objectives of this proposal are multi-faceted and involve diverse undergraduate and graduate students, as well as K-12 students and the general public, to address the challenges. This project will enhance the ScienceView website (<http://scienceview.berkeley.edu>) in the UC Berkeley's public science center at the Lawrence Hall of Science to educate the general public about basic atmospheric processes within the context of their own geographic area. The PI will develop a one-hour module that will be designed as a seminar presentation for first-year undergraduate students in the PI's department and for public presentation during CalDay, the campus' open house for the public and prospective undergraduates and their parents. The PI will develop a 1-week module on environmental flow modeling that will be prepared for an upper-division computational methods course being developed by several faculty members in the Berkeley Civil and Environmental Engineering department.

Paul Markowski at Pennsylvania State Univ., in his CAREER project, investigates the radiative effects of cirrus anvils and their shadows on the dynamics of long-lived convective storms. He is developing a suite of interactive numerical models for use in a variety of courses for undergraduate and graduate students and creates an interactive museum exhibit that showcases atmospheric research on severe storms and fully immerses visitors in the discovery process that defines science.

Heping Liu, Jackson State University, in his CAREER project, addresses turbulence structures in a disturbed atmospheric surface layer. He involves a number of African-American students in his project, both in research and education activities. In conjunction with this project, he added a field trip component to his course entitled "Micrometeorology" and brings his class (5-10 African-American undergraduate students) to his micrometeorological tower to conduct field work. Also, some mini-projects are developed to attract 5 to 10 African-American undergraduate students each year to be involved in research.

The variety of projects and approaches to educational activities should insure the development of talent in Physical and Dynamic Meteorology for years to come.

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

1.) Atmospheric Chemistry

The Atmosphere Section made several awards for innovative new instrumentation with commercial potential, including ATM-0450466 to Donald Stedman of the University of Denver under the Major Research Instrumentation (MRI) program. Stedman and colleagues designed and constructed a novel, low-cost, optical sensor for on-road emissions capable of measuring carbon monoxide,

ammonia, sulfur dioxide, as well as other pollutants from passing vehicles remotely and at trace levels. A small number of on-road vehicles are responsible for the majority of mobile source pollution and remotely sensed roadside emission measurements can be a low cost and effective means of characterizing those few on-road gross emitters of pollutants. In a field study the Stedman group was able to catalog the make, model year and fuel type of vehicles and use these data to study on-road pollution patterns. With respect to emissions chemistry they determined that vehicular ammonia emissions, which have increased over the past two decades, peak when a vehicle is around 10 years of age. They also found that sulfur dioxide shows a statistically significant positive correlation with the lowest measured emissions from the newest vehicles, a counterintuitive result given the sulfur trending down in motor fuel. They attributed this result to newer cars emitting an unmeasured sulfur compound due to a more active catalyst. The sensor technology is especially innovative and the resultant low-cost instrument provides robust and representative data of broad societal relevance.

Researchers at University of California San Diego led by Kimberly Prather under NSF Atmospheric Chemistry Program support through the Major Research Instrumentation (MRI) program have developed a new instrument that advances the detection of aerosol size and chemical composition at higher time resolution, and used this new technique to investigate particle nucleation and growth, and the role of particles in cloud formation (ATM-0650659). The Aircraft Aerosol Time-of-Flight Mass Spectrometer (AATOFMS) was successfully deployed on the NSF/NCAR C-130 and collected size-resolved chemistry of individual particles on 15 research flights. A major early finding was that dry lake bed dust particles from the Nevada/Utah region were found to dominate the measured cloud nuclei at all particle sizes in the Wyoming region, suggesting differences in particle chemistry, leading to kinetically-limited growth of different single particle types that play a major role in cloud formation. The development of the AATOFMS instrument and its deployment on a research aircraft have given researchers the opportunity to look with unprecedented resolution at particle types that play a key role in cloud formation. The dry lake bed finding may be significant when faced with the possibility of enhanced dust storms due to a warming climate.

2.) Climate and Large Scale Dynamics

CLD funded a number of proposals during the FY07-09 period that led to the development of key instrumentation, important new datasets, and field experiments involving large collaborative proposals. Some of the projects that CLD funded during the period reviewed that have the potential to significantly contribute to an improved understanding, characterization, and/or predictability of different components of the climate system at different scales are highlighted below:

- 1) The Constellation Observing System for Meteorology, Ionosphere, and Climate (COSMIC; Lead PI, Ying-Hwa Kuo, NCAR). The six micro-satellites that make up COSMIC's GPS-based observing system were launched on April 14, 2006. Following several months of testing, NOAA's National Centers for Environmental Prediction (NCEP) commenced operational use of the COSMIC data in early 2007. Several other operational centers, including the European Centre for Medium-range Weather Forecasting (ECMWF), the United Kingdom Meteorological Office (UK Met Office), Météo-France, and the Canadian Meteorological Centre (CMC) have also begun operational assimilation of COSMIC data. As of December 2007, there were over 700 registered users of the data, representing major U.S. and international universities, leading operational weather centers, research laboratories, and several private companies. CLD has continued to invest substantial resources (\$15,385,149.00) in the program. The products from COSMIC have already proved invaluable for many applications, including improvements in weather prediction. COSMIC data (via the COSMIC data archive, CDDAC) have already had a significant positive impact on operational forecasting. For example assimilation of COSMIC data at

ECMWF reduced the fractional 100-hPa temperature RMS errors by 11% for the 12-h forecasts over the Southern Hemisphere.

- 2) Development of the Active Temperature Ozone and Moisture Microwave Spectrometer (ATOMMS) cm and mm-wave Occultation Instrument (Lead PI: Emil Kursinski, U. of Arizona). ATOMMS is a novel technique that takes advantage of the COSMIC GPS infrastructure to develop capability for determining how turbulence affects measurements and the retrieved profiles of temperature, water vapor and ozone. The technologies in ATOMMS, originally developed for radio astronomy, can provide answers to critical questions about the climate of the earth to far greater precision and resolution that have been available before. New applications of terahertz technology (employed in ATOMMS) beyond radio astronomy may prove to be very valuable in areas such as earth remote sensing, planetary science, hazardous materials detection, and medical imaging.
- 3) The Cosmic-ray Soil Moisture Observing System (COSMOS: Lead PI, M. Zreda, U. of Arizona). COSMOS involves measuring low-energy cosmic-ray neutrons above the ground, whose intensity is inversely correlated with soil water content and with water in any form above ground level. Cosmic-ray moisture probe is a new instrument but built on existing, tested technologies and promises to provide a rare and useful network for measuring soil moisture content. An initial proof-of-concept project lead by PI Zreda showed generally encouraging results. Therefore, COSMOS has the potential to significantly improve the accuracy of soil moisture measurements.
- 4) The Center for Multiscale Modeling of Atmospheric Processes (CMMAP: Lead PI, David Randall, Colorado State): CLD has continued to commit substantial funding (\$3,989,219.00 /year) to this highly productive STC site. CMMAP has delivered impressively on all fronts (research, education, diversity, and knowledge transfer). In particular, the CMMAP team has built novel modeling tools/parameterizations that are already being implemented in global climate models (e.g., COLA coupled Ocean-Atmosphere model; CCSM) to improve simulations of the seasonal-to-interannual climate variability, for example due to phenomena such as the Madden Julian Oscillations (MJO).
- 5) North American Regional Climate Change Assessment Program (NARCCAP: Lead PI, Linda Mearns, NCAR). NARCCAP's primary goal is to produce high-resolution climate change simulations in order to investigate uncertainties in regional scale projections of future climate and generate climate change scenarios for use in impacts research. As such, NARCCAP is developing a unique, high-resolution, regional climate change scenario dataset that are beginning to be used by a broad range of user communities.
- 6) Center for Ocean Land and Atmosphere interactions (COLA: Lead PI, James Kinter, COLA): COLA is supported by CLD at a total budget of about \$16,973,461.00 to continue and expand the investigation of seasonal-to-interannual predictability in a changing climate, including the influence of global change – changing greenhouse gas concentrations, aerosols and land use – on the interactive ocean-atmosphere-land-cryosphere system. CLD has committed multi-year, multi-million dollar funding to COLA to continue developing and improving coupled ocean-land-land modeling tools. COLA has pioneered work on, and demonstrated the importance of, land-atmosphere interactions, in particular, in modulating the regional effects of remote forcing by ENSO or other oceanic anomalies. COLA collaborates with the CMMAP in some of their efforts aimed at improving the prediction of climate at seasonal-to-interannual timescales, as is also highlighted in (3) above.
- 7) C4: Cloud-Climate Feedbacks due to Extra-Tropical Clouds Systems (Lead PI,

Veerabhadran Ramanathan, UC-San Diego/Scripps). CLD has continued to support this former STC site, with focus on investigating the extratropical clouds systems of the Pacific Ocean, one of the major contributors to the overall negative global-mean net cloud forcing, and which plays an important role in global and North American climate variability and change. The two primary components of the project are: (i) estimate aerosol and cloud radiative forcings and examine aerosol-cloud interactions in the extra tropical systems of the Pacific Ocean; and (ii) investigate the roles of aerosols and large-scale dynamics in regulating cloud albedo over the Pacific Ocean and the cloud-climate feedbacks. This project also included the Cheju ABC Plume-Monsoon Experiment (CAPMEX: 2008) off Cheju Island, South Korea. CAPMEX provided in situ aerosol and cloud data in both the polluted and pristine warm cloud systems over the western Pacific Ocean. These data are an important resource for evaluating simulated aerosol-cloud interactions in models.

- 8) VAMOS Ocean-Cloud-Atmosphere-Land Study (VOCALS: Multiple PIs). VOCALS involved intense C-130 field observations as well as numerical modeling of the marine boundary layer over the otherwise sparsely observed Southeast Pacific Ocean. The field data from the VOCALS Regional Experiments (VOCALS-Rex) have been used to demonstrate the importance of precipitation in stratocumulus clouds to the energy and moisture budget of the marine boundary layer, cloud mesoscale and microscale structure, and albedo. New insights regarding the tight interplay between aerosols, clouds, and precipitation in the clean marine boundary layer have also been enabled through these VOCALS-Rex field data analyses, and these are being used to improve parameterization in numerical models by the modeling teams that are participating in the VOCALS program.

3.) Paleoclimate

This program supported the instrument upgrade for the Lamont-Doherty Earth Observatory stable isotope facility. The total cost for this upgrade was \$811,868, of which AGS provided \$641,868. Funds from the AARA and FY10 funds supported this grant to Dr. Braddock Linsley (AGS-0959148). This represented a significant investment in the paleoclimate community's analytical infrastructure.

Support was also provided to acquire a single collector high-resolution double-focusing magnet sector-field mass spectrometer (HR-ICP-MS) for the University of California, Irvine (Kathleen Johnson, PI AGS-0821841) to be used by the paleoclimate community to make high precision measurements of elemental concentrations and isotope ratios organic and inorganic solution matrices used in paleoclimate research.

4.) Physical and Dynamic Meteorology

In PDM, eight MRI awards were made totaling just over \$3.8M; the largest award at \$875K and the smallest \$156K. The award periods ranged from 1.5 to 4 years, the shorter time periods for acquisitions and the longer for instrument development. Both will support scientific endeavors well into the future and represent good investments.

Additionally, PDM supported instrument development, upgrades, or adaptations through four new project awards and three supplements or contract continuations. These totaled \$1.32M (total requests, not yet awarded, of \$2.40M) and included the Doppler on Wheels, unmanned aircraft systems, a system for electrical and meteorological measurements in convective vortices, preliminary work for the development of the next-generation storm-penetrating aircraft and an eye-safe lidar for horizontal vector wind field measurement. Two of these were EAGER proposals; all represent highly-desired new or upgraded instruments which will support discovery and learning.

Additionally, PDM supported instrument development, upgrades, or adaptations through four new project awards and three supplements or contract continuations. These totaled \$1.32M (total requests, not yet awarded, of \$2.40M) and included the Doppler on Wheels, unmanned aircraft systems, a system for electrical and meteorological measurements in convective vortices, preliminary work for the development of the next-generation storm-penetrating aircraft and an eye-safe lidar for horizontal vector wind field measurement. Two of these were EAGER proposals; all represent highly-desired new or upgraded instruments which will support discovery and learning.

PART C. OTHER TOPICS

C.1. Please comment on any program areas in need of improvement or gaps (if any) within program areas.

None Identified

C.2. Please provide comments as appropriate on the program's performance in meeting program-specific goals and objectives that are not covered by the above questions.

The view of the COV is that previous sections adequately addressed the important aspects of the section's performance.

As the P2C2 has been in existence for only 2 years, it's premature to judge the performance. That said, the results from the precursor, ESH, have been successful, but that's outside the scope of this COV. Returning to P2C2, the two primary objectives,

"1) to provide comprehensive paleoclimate data sets that can serve as model test data sets analogous to instrumental observations; and 2) to enable syntheses of paleoclimate data and modeling outcomes to understand the response of the longer-term and higher magnitude variability of the climate system that is observed in the geological record."

These are long-term goals, and haven't yet been realized to the extent desired. This is because the community is still developing the data sets, and greater proposal pressure is needed from PIs who will integrate datasets and convert them into test data sets for modeling purposes.

The COV was of the view that the AS should consider developing a long-term Strategic Plan for the section (in harmony with the overall Directorate (GEO)'s Strategic Plan). This would help in evolving and growing new programs, taking advantage of one-time large chunks of funding such as ARRA, and enabling in-house (internal) audit of the research, education and outreach productivity of the section.

C.3. Please identify agency-wide issues that should be addressed by NSF to help improve the program's performance.

C.4. Please provide comments on any other issues the COV feels are relevant.

C.5. NSF would appreciate your comments on how to improve the COV review process, format and report template.

The COV commends AS and the NSF for the effort expended on the COV review process. Program officers and staff were incredibly responsive to requests and generous with their time. The committee's only substantive concern about the COV review process involved Part B – Results of NSF Investments. The NSF does not keep relevant metrics to quantitatively evaluate performance from its granting activities (e.g., papers published, conference presentations made, etc.). The COV understands the reasons for this policy (i.e., manpower requirements to search out these records) and so has adopted a qualitative approach of highlighting relevant projects and grants that likely will produce significant advances in the science covered by AS.

Question A.1.3 seems very much beyond the scope of the COV, i.e., to make judgments about what reviewers say in their reviews. More pertinent to the COV is the assessment of the approach of the PO in using reviewer comments in their decision-making process and how they documented this use.

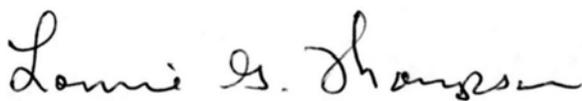
Specific improvements to the process include:

Recommendations

Inform the COV members about the computer software system (ejackets) that will be provided, and let members know that they can use their own personal computers in lieu of the ones provided by NSF. The software system became very slow, and nearly inoperable in the second half of the first day.

- Improvements to the computer and software system were also identified as a weak spot in the last COV and it is clear that there's been an improvement since then.
- Give COV members access to the ejackets BEFORE they arrive, on site, so that we have more time to review the portfolios, and THEN can spend more time, on site, talking with Program Officers, and each other, before filling out the review template.
- Add a Section description to the COV review packet, analogous to the Program descriptions provided to the COV at the start of the review.
- Add a presentation on the major findings of the last review and subsequently what changes were made as a result, including explanations of recommendations that were not taken. Some of this was included, but more information would be an improvement.
- Include statistics about how well the community of scientists has been doing at placing students in various positions, both academic and other professional positions.

SIGNATURE BLOCK:



For the [Replace with Name of COV]
[Name of Chair of COV]
Chair