**Advisory Committee for Geosciences (AC/GEO)**

**October 19-20, 2016**

**Meeting Minutes**

**AC GEO Attendees:**

Dr. George M. Hornberger (Chair)

Ms. Vicki Arroyo

Dr. Paul Bierman

Dr. Catherine Constable

Dr. E. James Dixon

Dr. Scott C. Doney

Dr. Rana Fine

Dr. Jose D. Fuentes

Dr. Kip Hodges (via teleconference)

Dr. Pamela Kempton

Dr. W. Berry Lyons

Dr. Shirley A. Pomponi

Dr. Kim Prather

Dr. Joshua Semeter

Dr. Julienne Stroeve

Dr. Gregory Sullivan

Dr. Cindy Lee Van Dover (via teleconference)

Mr. David H. Voorhees

**Absent AC GEO Members:**

Dr. Gregory J. Hakim

**NSF Senior Staff:**

Dr. Roger Wakimoto

Dr. Marge Cavanaugh

Melissa Lane

**Wednesday, October 19th**

**Welcome & Introductions**

Dr. Hornberger convened the meeting and welcomed all participants; he invited those present and on the phone to introduce themselves and noted that Dr. Kip Hodges would be joined via teleconference at 11:00 a.m.

Dr. Hornberger reviewed the day’s agenda, noting the tight schedule, and requesting that discussion be held until the open session, scheduled for the afternoon.

**Update on NSF GEO Activities**

*Roger Wakimoto, AD GEO*

Remarks from the Assistant Director of GEO Sciences. Dr. Wakimoto noted that he would offer a compressed presentation, to preserve time for invited speakers; a period of open discussion has been scheduled for the afternoon and at that point, he said, the council could further discuss the topics presented. Dr. Wakimoto remarked that clarifying questions were welcome during his presentation.

10 Big Ideas for Future NSF Investments. Dr. Wakimoto reported that the 2016 NSF Director’s retreat was unique in that directors were asked to resist budget considerations in the discussion of the future NSF research agenda. In this climate of flat budgets, bringing considerations of costs into preliminary planning discussions can constrain thinking. At this year’s retreat, directors were asked to discuss exciting new directions and opportunities in science, without consideration of required funding. The discussion resulted in the identification of many ideas, which were then winnowed to six research and four process ideas. Dr. Wakimoto encouraged AC GEO members to review the materials distributed on the 10 Big Ideas; he suggested that Navigating the New Arctic might generate the most questions and discussion among AC GEO members.

Dr. Wakimoto remarked on the convergence of interest and activities with the identification of Navigating the New Arctic: a White House Science Ministerial focused on the Arctic was held in September of this year; the National Academy of Sciences (NAS) Polar Research Board convened a panel after this gathering. In addition, the Office of Science and Technology Policy released the Interagency Arctic Research Policy Committee (IARPC) draft Arctic Research Plan 2017 for public comment, and the American Geophysical Union (AGU) has dedicated a session at their upcoming Fall meeting to “Sustained Arctic Observations.”

Dr. Wakimoto also noted that Navigating the New Arctic is closely related to other identified Big Ideas. The success of the Arctic enterprise is uniquely dependent upon the inclusion and engagement of indigenous communities, reflected as a priority in “NSF-Includes: Enhancing Science and Engineering through Diversity.” “Harnessing Data for 21st Century Science and Engineering” will also be key to the success of these efforts. The Arctic also provides a living lab reflecting changing ecosystems, which will be critical to the “Understanding the Rules of Life: Predicting Phenotype” initiatives. The Arctic initiative also links into “Convergent Research at NSF.”

ScienceDebate.org. Dr. Wakimoto reported that several science societies and agencies, including several related to geosciences, collaborated to solicit science questions for the Presidential candidates. Hundreds of questions were collected; these were consolidated and winnowed to 20 questions which were presented to the candidates. Their answers have been received and are available in full at <http://sciencedebate.org/20answers>.

Dr. Wakimoto reviewed brief excerpts of the candidates’ responses on research, climate change, water and ocean health. He noted that both candidates expressed support for science research and noted the importance of issues related to water.

Reproducibility and Robustness of Results. Dr. Wakimoto reported on a Dear Colleague Letter (DCL) reaffirming interest in proposals related to “enhancing the validity of the data and outcomes of research in all GEO programs.” He noted that the DCL was released in response to rising questions regarding the challenge of reproducibility and robustness of results in computer simulations, as well as skepticism expressed in the community that proposals focused on reproducibility would be funded by NSF.

Seeking Community Input on NSF Polar Programs Realignment. A DCL from Joan Ferrini-Mundy, Assistant Director, Education and Human Resources (EHR), and James Old, Assistant Director, Biological Sciences, solicited input on questions related to the proposed realignment. Dr. Wakimoto reported that responses were received from a cross-section of the science community, and that the NSF Director is nearing a final decision. Dr. Wakimoto suggested that AC GEO might provide input to the Director in the afternoon session, but predicted that she would not offer much detail in her reply at this time.

Highlights and Updates from GEO.

* Antarctic Medical Evacuation. Dr. Wakimoto reported on global press coverage of the successful winter evacuation of two workers at the South Pole. He commended the Polar Programs on the efforts and skill required to organize the evacuation.
* Merit Review Pilots. Dr. Wakimoto reported further data regarding the impact of eliminating program deadlines. The Earth Sciences (EAR) Instruments and Facilities (IF) Program saw a dramatic drop in the number of proposals received, once deadlines were eliminated. It was not clear whether this drop would be sustained or temporary. After 3 years of solicitations without deadlines, the lower submission rate appears to be sustained; in fact, it dropped further and seems to have now leveled off.

Other programs have seen similar drops of 50 percent or more. Dr. Wakimoto noted that it remains to be seen whether the application numbers will remain at these lower levels. Similar pilots will be undertaken in other directorates. Dr. Wakimoto reported that Alex Isern had been invited to present to other directorates and senior leadership about these pilots.

Some efforts have been undertaken to survey Principle Investigators about this change; while some show strong preferences for or against deadlines, the majority do not state a preference. Dr. Wakimoto noted the need to assure that this change does not harm demographics; he noted the need to assess its effect on young scientists in particular. Assessing whether proposals have improved in quality will also be important. An article on this change was published in *Science* after the Spring meeting; it has been one of the most read articles published recently.

Some work has been done to measure the response of PIs to the elimination of deadlines. Some PIs have shown preference for deadlines or no deadline, but the majority do not report a preference.

* Regional Class Research Vessels. Dr. Wakimoto reported that the President’s budget requested funding for two new ships; the Senate Appropriations Committee increased the proposed allocation to 3 ships. The House Appropriations Committee proposed no funding for new ships. Dr. Wakimoto stated that there is no way to know how these negotiations will end. He noted that Representative Culberson, the Chair of the House Appropriations Committee, had noted that the House budget did not propose directorate-level funding, and that might be seen to be progress.

Dr. Wakimoto noted that the House appropriations represents one of the few times Congress has gotten involved in these accounts, whether increasing or decreasing it; he stated his hope that it will not represent a new trend in the budgeting process.

* Ocean Observatories Initiative (OOI). Dr. Wakimoto commended the transition of OOI into operations; he remarked that the underwater side captured a volcanic eruption in real-time, thus proving the intent of the program, to gather continuous real-time data.
* Future of Atmospheric Chemistry Research. Dr. Wakimoto noted the publication of results of a large National Academies study on the future of atmosphere chemistry research. He noted that this area includes carbon dioxide release, the ozone hole, pollution.
* CubeSat Revolution. The use of these small, low-cost satellites, which are launched through planned rockets, was begun at NSF and is now garnering interest from other agencies. The use of CubeSats is expected to revolutionize science, communications, and other fields. Dr. Wakimoto commended the executive summary of a report on CubeSats: <http://wwww.nap.edu/23503>
* NSF’s Intergovernmental Personnel Act (IPA) Program. Dr. Wakimoto reported that the review of the IPA program has generated significant discussion; the review is ongoing. No changes have been announced to date. Dr. Wakimoto asked AC GEO members to review the presentation made by Joanne Turnow to the National Science Board (available on the AC GEO website); he also suggested they might ask the Director about this review.

Dr. Wakimoto briefly reviewed the speakers scheduled for the current AC GEO meeting. He remarked that the questions to the candidates included a question on reproducibility, which would be addressed in more detail by Victoria Stodden. Dr. Wakimoto noted he had limited his own remarks about the budget during his presentation, in light of presentations by Michael Sieverts, Director of the Budget Division of the Office of Budget, Finance and Award Management, and Tony Gibson, Senior Advisor for Legislative Affairs at the Office of Legislative and Public Affairs (OLPA).

**Panel Discussion on Budget & Congressional Affairs**

*Michael Sieverts, Director, Office of Budget; Anthony Gibson, Senior Advisor, Office of Legislative & Public Affairs*

Mr. Sievert noted that, normally at this time, the Office of Budget would be in reviewing their proposed budget for the coming fiscal year. However, during an election year with an outgoing administration, the Administration chooses not to prepare a budget proposal for the year after the current administration will leave. Mr. Sievert noted that this decision provided him with a bit of a respite, although there will be an intense period of planning after the election, increasing in intensity after the inauguration. The normal 9-month Office of Budget process will be condensed into approximately 3 months.

Mr. Sieverts reminded AC GEO members that the Bipartisan Budget Act of 2015 was passed, and House Speaker John Boehner resigned just one year prior. This 2-year agreement for FY16-17 has implications for FY18. The Bipartisan Budget Act provide relief from sequestration; funding in FY16 was set at 5 percent higher than the caps set by sequestration; funding for FY17 at 3 percent higher than the sequestration caps. If the sequestration caps resume in FY18, the discretionary budget will be decreased by 0.4 percent; Mr. Sievert remarked that one of the incoming administration’s first decisions will be whether to allow this reversion to sequestration or to seek continued relief.

Mr. Sievert moved to the FY17 NSF budget request to Congress, noting that the NSF budget was, for the first time, divided into mandatory and discretionary spending. The discretionary spending request of $7.564 million is a small increase over FY16 (1.3 percent); the total request is for a more substantive increase of 6.7 percent; the administration suggested a package of $400 million in mandatory spending, to provide more robust support for science.

The Administration’s budget structure was seen to be a way for the administration to increase investments without challenging the discretionary funding caps; the administration has said the mandatory spending request is a one-time-only request. Congress made it clear that it will not consider the proposed mandatory spending; that $400 million was immediately removed.

The Senate mark-up made few changes in the budget request, apart from a 25 percent increase in funding for the research vessels; the Senate budget funds the NSF at roughly the FY16 level. The House removed all the research vessels from the budget, made small increases in Agency Operations and Award Management (AOAM), and proposed a lower overall budget.

Mr. Sievert reported that the House and Senate are currently working out these budget differences. The issues that must be addressed include:

1. Determining what number of research vessels will be funded.
2. Support for Major Research Equipment and Facilities Construction (MREFC); Mr. Sieverts noted that both the Senate and House budgets call for a review of MREFC funding on a semi-annual basis.
3. AOAM funding. While the House proposes more funding than the Senate, neither provides the funding necessary for the foundation to complete its move to Alexandria, Virginia. Mr. Sievert suggested that reallocation of resources might be used to address the shortfall.
4. The National Science Board is required, in the Senate budget to prepare report on the impact of Facilities Operation and Management funding on Research and Related Activities. That requirement is not included in the House budget.

Mr. Sievert noted that the government is currently operating under a continuing resolution (CR), which expires December 9, 2016. Congress will return after the election to complete action on FY17.

Dr. Wakimoto noted that the American Geophysical Union Annual Meeting will be held December 10. Mr. Sievert responded that failure to extend the CR will impact travel; federal employees would have to fly home. He offered a slide on the number of days after the beginning of the FY that NSF has received its appropriation, and suggested that, given the developing pattern, it might be early to expect an appropriation in December.

Mr. Gibson suggested that 2009 provides the closest analogy, although, he noted, there was a sense of urgency to address the financial crisis in 2009. That sense of urgency is not currently present. He noted that the Budget Agreement was intended to provide relief from the political challenges of setting the budget for FY17; that has not proven to be the case.

Mr. Gibson reported that staff are still in place while members have left town to campaign; staff are doing all that they can to prepare the budget while their members are gone, and OLPA staff are in discussion with Congressional staffers. He noted that it is a good time for members of the community to contact appropriations staff and let them know their feelings about funding for science, the role of geosciences, and the need for research vessels.

Mr. Gibson noted that the NSF is, in some ways, competing with law enforcement, which is in the same budget bill. He noted the perceived need for Congress to show strength on law enforcement, as well as issues such as recent email incursion. NASA and other sister science agencies are all the same bill, and are each struggling for precious resources, which are, at most, flat.

Mr. Gibson remarked that he never encourages discussion of doubling or tripling the NSF budget, as he perceives these to simply “close the door.” He encouraged AC GEO members to recognize the severe pressure faced by appropriations staff, and reported that much of the controversy about climate change—and the shadow that controversy placed on geosciences—had been put to rest. The argument for allowing scientific curiosity and the development of data points has been made and mostly accepted by the legislators who make policy.

Mr. Gibson noted that appropriations staff are preparing a competes bill, which addresses reauthorization. He noted significant differences between the House- and Senate-passed bills, and asserted that committees and individuals seek to pass legislation and make progress. Mr. Gibson noted concerns developing over the last 19 months, that a bill could emerge and pass within a single day. He encouraged AC GEO members and their association to contact legislators about any troubling or desired aspects of the House or Senate bill, regarding the direction of Science and Technology in the next 3-5 years. He noted that staff are used to hearing from OLPA, and the validation of new voices would be helpful.

Mr. Gibson closed by encouraging AC GEO members to make their voices heard, and to encourage the voice that have not been heard very much on science, such as business groups. He noted that the agency and academia have been involved, and suggested that the “third leg of the triangle” needs to be heard, regarding the importance of the NSF.

Discussion. A staff member asked Mr. Gibson to provide pointers to the current version of the bill, to facilitate specific references; Mr. Gibson replied that he would do so, through Ms. Lane.

Dr. Fine asked for further insight regarding the differing numbers of ships funded. Mr. Gibson suggested that “gamesmanship” might explain some of the difference: the less interested party in negotiations is often in the stronger position. He noted that there is real strain within the limited budget, and that there were some real questions regarding the use of current assets. OLPA staff have answered and debunked criticisms related to the academic fleet. He reported that the House Appropriations Chair had been hosted on one of the research vessels, seen the resources available and spoken to researchers.

Dr. Wakimoto remarked that Mr. Gibson or Karen Pierce accompany Assistant Directors when they make legislative visits, and commended the value of their counsel.

Dr. Cavanaugh requested further discussion of the role of the Government Accountability Office (GAO) review of MREFC projects. Mr. Sievert noted that the GAO is an arm of Congress which performs audit and review functions. Current proposals would require the GAO to review projects funded through the MREFC account on a regular basis; Mr. Sievert said this was seen to be duplicative of other oversight mechanisms. In addition, such review would require the development of relationships with an entirely new oversight mechanism; the NSF does not belief it would be helpful.

Dr. Hornberger asked Mr. Sievert whether he was optimistic about the longer budget view—2020 or beyond. Mr. Sievert noted plans for modest increases through 2020, and significant pressures on spending. Compelling needs, such as the Veterans’ Administration, could consume the entire increase in discretionary spending. Mr. Sievert stated that there is little reason for optimism at the current cap levels, but that the President had made statements regarding the inadequacy of the current caps, and the need for their correction.

Dr. Wakimoto asked about other aspects of budgeting during a new administration. Mr. Sievert noted that the last two administrative turnovers had been marked by unusual circumstance: in 2000, the Bush v. Gore election was not settled until December; the 2009 transition occurred amid a financial crisis. These challenges will not be present in the current transition.

Dr. Bierman asked for further clarification of “old caps” and “new caps.” Mr. Sievert replied that the “old caps” are those written into law and known as “sequestration.” The Bipartisan Budget Agreement of 2015 changed these caps for FY15 and FY16, essentially putting decisions regarding sequestration off to the incoming administration.

**COV Reports**

* **AGS Atmosphere Section** *Kim Prather, AC GEO; Patrick Harr, Section Head/AGS*

Dr. Prather reported on the Atmosphere Section Committee of Visitors, which was convened March 31 – April 1, 2016. The COV was chaired by Dr. Prather and Dr. Anantha Aiyyer of North Carolina State University. Two representatives from Atmospheric Chemistry, Drs. Patricia Quinn and Luisa Molina, participated.

The COV was asked to evaluate the quality and effectiveness of the merit review process, the selection of reviewers, management of the program, and any questions about the portfolio. In addition, they reviewed the Postdoctoral Research Fellows (PRF) program.

Approximately 25 percent of 1,663 program jackets (2013-15) where chosen and highlighted by program directors. The COV noted that review analyses by program directors is “quite impressive.” The COV was also impressed with the thoughtfulness with which reviewers are chosen, and the care with which they addressed issues. The COV also considered the no-deadline approach to proposal within the Atmosphere Section, and found it to be appropriate and effective, particularly for field projects that can emerge quickly.

The most substantial discussion addressed broader impacts, and way to encourage the community to take this criterion more seriously and address it more thoroughly. The COV was told that this concern was present across the NSF; the COV encouraged the Atmosphere Section to seek to address this concern and to continue to communicate to the community the importance of broader impact.

Overall, the COV had few concerns; they noted that the success rate for early career PIs was below total program average success rates, and discussed this with Section staff. The Section believes that the ad hoc reviewer format allows more direct communication between the PI and the program director, and that this will prove to be of benefit to early-career PIs.

The selection of reviewers appeared to be appropriate, and reviewers of high quality. Reviewer comments were generally extensive and relevant. Conflicts of interest were resolved appropriately by the program directors. A comment was made regarding the need for more non-U.S. reviewers; the COV felt the current mix was appropriate.

The COV found the Atmosphere Section programs to be well managed in nearly all aspects of dwell time, portfolio balance, program responsiveness and program planning. The COV noted the challenge of balancing support between large field studies and individual awards; the COV felt the program was doing well on this front, and encourages continued close coordination with the National Center for Atmospheric Research (NCAR). A discussion was held regarding whether top-down or bottom-up development of large studies was preferred; in the Atmosphere Section, most studies develop out of the community; the COV found this to be appropriate.

The geographic distribution of awards is somewhat uneven, and reflects the uneven distribution of institutions with large and mature atmospheric science programs. The COV noted efforts through the Experimental Program to Stimulate Competitive Research (EPSCoR), and suggest that local researcher be invited to participate in large studies located in regions that lack well-developed research infrastructure.

No concerns were noted regarding Program Planning and Prioritization. The COV encouraged the program to prioritize participation of under-represented groups. Female participation has increased, but other under-represented groups submitted only 5 percent of all applications.

Regarding the PRF program, the COV noted that postdoctoral applicants appreciate the ability to choose their institution, as they receive the awards directly. This structure, however, places a substantial administrative burden on program directors. The COV discussed strategies for reducing this burden; removing PRF application deadlines might prove helpful. The Section is considered asking for justification for the host institution in some cases, as well as greater involvement from the PRF mentor.

Dr. Prather concluded by reporting that the COV found the Atmosphere Section to be doing well, and program directors to be very thoughtful. The efforts made by reviewers was very impressive, particularly in terms of proposals that were declined. The COV noted that the Section could improve upon participation by under-represented groups, communications to the community regarding broader impacts, and better balance between early career and established PIs.

Discussion. Dr. Constable asked if the PRF program in the Atmosphere Section differed from those in other programs; it does not. Dr. Constable suggested that a collective approach might be useful. Paul Shepson, Division Director in Atmospheric Sciences, reported that a committee is currently considering the best ways to protect the current flexibility of the program, while reducing the burden on PIs and program directors. He offered his thanks to Dr. Prather and the COV for their efforts.

Dr. Fuentes asked for more insight regarding the low numbers of applicants from under-represented groups. Section Head Patrick Harr reported that Atmosphere Section staff visit regional universities to conduct outreach to under-represented groups and early career PIs; the Section is proactive in seeking to increase the numbers of proposals submitted and approved. Dr. Fuentes suggested that the need for increased representation might be addressed through efforts related to broader impacts.

Dr. Wakimoto noted that he had been impressed by a presentation by Susan Renoe, Director of the National Alliance for Broader Impacts (NABI), which seeks to create a community of practice that fosters the development of sustainable and scalable institutional capacity and engagement in broader impacts. He suggested the director might speak to AC GEO at a future meeting.

A participant suggested that the Graduate Research Fellow Program might serve as a model for the PRF; Dr. Prather replied that graduate research fellows know their institutions in advance of their award. Dr. Shepson explained further that PRF program does not include institutional overhead; the burden is on the awardee to manage and develop their benefit package, which increases the workload and can be confusing. The flexibility is intended, but also presents challenges. Among other options under consideration are enabling the postdoctoral student to be the PI, while the university manages the award; different universities are more and less comfortable with that approach, which would include overhead costs.

Dr. Bierman noted challenges at his institution in determining, for example, how to provide IDs for these awardees. He suggested these issues be addressed across the NSF.

A staff member reported that the Polar Program had a similar program, about which the concern was the intended mentoring role, and whether it was appropriate for the PI to have complete discretion in this area. Regarding the administrative challenges discussed, this award included an allowance for PI benefits, as well as an allowance to the university, to offset costs related to accommodating the awardee. He suggested this model might work for the Atmosphere Section.

Dr. Voorhees asked about outreach to undergraduates from under-represented groups. Dr. Prather replied that the Section is encouraged to consider how to involve students from smaller schools in large field studies. Dr. Harr noted that the Section benefits from its relationship with NCAR and their relationships with undergraduate programs.

Dr. Constable moved that the COV Report on the Atmosphere Section be accepted by AC GEO; Dr. Dixon seconded the motion, which passed unanimously.

* **PLR Antarctic Section** *Rana Fine & Greg Sullivan, AC GEO; Eric Saltzman, Section Head/PLR*

Dr. Sullivan noted that he would make the report to AC GEO, as the COV Chair, Susan Humphris, was not available. He noted that Dr. Humphries was an excellent chair for the COV, who helped to make the process advance smoothly; the staff and programs officers were also very helpful in provided needed materials.

Dr. Sullivan reported that the COV sought to assess the quality and integrity of the review process, and the portfolio balance. Overall, the COV was very satisfied with those aspects of the program. COV members reported finding value in seeing with more detail how decisions were made, and felt that the process was appropriate. Dr. Sullivan noted that serving on the COV allows members of the community to see the review process as they assure its integrity.

Dr. Humphris served as Chair of the COV; Dr. Sullivan served as liaison from AC GEO. The COV was comprised of 9 members who participated in teleconferences to set up the review, conducted May 17-19, 2016. Thirty percent of 615 total actions were reviewed.

The COV was very impressed with the integrity of the review process, and found the combination of a hoc and panel reviews to be effective and appropriate. Program officers provided very high quality review analyses.

The COV made observations in three categories: those related to the Antarctic Section (ANT), NSF-wide recommendations, and recommendations related to the aligning of ANT within GEO.

Regarding the ANT, the COV found it to be thorough in documenting conflicts of interest. Some suggestions were made regarding identifying these conflicts earlies in the process; staff have been working to do so. The COV commended the excellent Section management, and its appropriate responses to emerging research opportunities.

The COV noted some challenges that are common across NSF. These include: clearly communicating the meaning of “broader impacts” to the community, streamlining the tracking of the ad hoc review process, increasing the involvement of under-represented groups, and addressing NSF travel restrictions.

Dr. Sullivan noted that the meaning of “intellectual merit” was clear and its review well-executed; broader impacts are less well addressed, in terms of the meaning of the criterion and its evaluation. The COV noted that committees appeared to struggle to document their review and evaluation of broader impacts.

The COV noted significant advantages and disadvantages from its new position within the GEO Directorate; these are detailed in the report.

The COV provided 13 recommendations to the ANT; Dr. Saltzman, ANT Section Head, offered some detail regarding the Section’s response to three of these recommendations.

1. The COV asked about the breadth of the review data base, and whether the ANT review poll was appropriately extended beyond Antarctic reviews. Staff report that more than 70 percent of request are made outside ANT; the response is slightly more than 50 percent, which is in line with other programs.
2. On the recommendation of COV, staff reviewed the success rate of new reviewers, and found that 10 percent of awards are to early career or first-time reviewers. ANT believes this to be a healthy ratio.
3. The COV asked about structural challenges to research connecting polar and non-polar regions; Dr. Saltzman noted that the ANT solicitation specifically includes this type of research. He recognized that there may be misperceptions within the community that lead to a low number of such applications.

Discussion. Dr. Fuentes noted Dr. Wakimoto’s earlier remark that participation by native communities is essential to research; Dr. Saltzman noted that the conversation was more appropriate for the Polar than ANT program.

Dr. Van Dover asked if broader impacts was weighted equally to intellectual merit. She also posed the example of an investigator from an under-represented group who fails to mention broader impacts; Dr. Van Dover asked if the program director might take the impact of such an investigator’s participation into account as a broader impact. Dr. Saltzman replied that investigators are required to address broader impacts specifically; there are no constrictions on the relative weighting in the review. He noted the lack of foundation-wide prescription regarding how to weigh broader impacts, but the clear sense that, overall, program portfolios should include a healthy balance.

Kelly Falkner remarked the program directors do consider the fact of an investigators’ identity within an under-represented group. They also explicitly consider whether a proposal is submitted by an early-career investigator.

Dr. Sullivan remarked that the COV was impressed with the way these various factors were weighed during the review process. Dr. Van Dover suggested that the community might benefit from knowing more about how these other factors are incorporated in the reviews; Dr. Sullivan agreed. Dr. Saltzman suggested that more could be done during panel orientation. Dr. Bierman agreed, noting that he had been involved in two COVs, each of which expressed admiration and surprise at the extent of this quality control and vetting.

Dr. Constable requested more detail regarding the disadvantages of ANT being inside GO and concerns about field diversity in reviews. Dr. Saltzman replied that the ANT had been strengthened with new program managers and a new science assistance. Dr. Falkner noted that ANT reviews proposals in every discipline from microbiology to astrophysics, and could not possible maintain representation from every domain. The program officers reach out beyond the program when necessary. Dr. Sullivan suggested that the comment regarding the field diversity might have emerged from concerns about a program with such a broad mandate being placed within a narrower directorate.

Dr. Fine moved that AC GEO accept the ANT COV Report; Dr. Semeter seconded. The motion passed unanimously.

* **PLR Arctic Section** *Berry Lyons, AC GEO; Roberta Marinelli, COV Chair; Simon Stephenson, Section Head/PLR*

Dr. Marinelli shared the COV report by phone; she identified herself as Chair of the COV and noted that Dr. Fine served on the committee. The review of the PLR Arctic Section followed the format of the previous COVs.

Highlights of the review include the COV’s finding of very high quality in the review process. The COV was impressed with the efforts of program directors to recruit an appropriate range of reviewer expertise; the documentation was clear and thorough, allowing COV members to easily follow the path from proposal through review and discussion to the final decisions. Dr. Marinelli noted that the COV did ask program officers to encourage panels to add more value to the review process through their comments. Dr. Marinelli noted that panel comments in many programs could be stronger.

Overall, the COV found the review process to be strong. COV members noted that the success rate for early career investigators is similar to that of more senior investigators. The COV was not able to assess the diversity of reviewers; Dr. Marinelli noted her impression that program officers seek to assure all components of the scientific community are reflected in the review process.

The COV expressed some concern about longer than desired dwell times for proposals, and discussed reasons for these delays. The report provides details of steps to be taken to improve response time.

The COV also discussed the generation of new research ideas within the Arctic Section, new ideas were described as emerging from the field. The COV noted the need to push the community at times; and the recommendation for more travel support for program officers to conduct outreach in the external community and seek new ideas. More program officers have been added to the Section recently, and should help with this issue.

The COV discussed the Arctic Observation Network (AON), and its tie to oceanographic sciences. This discussion led to consideration of the difficulty of sustaining long-term observations, and the challenge of handing these efforts off, to allow programs to continue to invest in developing new data.

Dr. Fine commended Dr. Marinelli on leading the COV, and remarked on the pleasure of working with Arctic staff.

Discussion. Dr. Kempton asked for more detail on AON; noting the remark in the report that it is “woefully underfunded.” Dr. Marinelli replied that the COV was not tasked with reviewing this program; their comments emerged in response to funding trends and the recognition that funds will be “locked up” if the budget does not grow or other agencies are not available to take over these programs. She noted this is a concern with long-term observation projects in general.

Dr. Marinelli noted that the COV might have suggested a review of the AON program. Dr. Kempton asked if this concern suggested the need for some process to review long-term observation projects. Dr. Marinelli replied that these projects are not funded indefinitely, and so are reviewed periodically; the COV saw an example of a long-term project that was discontinued. She noted that all long-term projects pose the challenge of maintaining them in the face of budget pressures and other needs.

Dr. Stephenson noted that funding long-term observations are a continuing challenge; the COV recommended the program staff to consider the unique role of the NSF in long-term observation network in the Arctic. The Long Term Ecological Research (LTER) model is very different from other types of projects the Section supports; COV recommendations are to consider that model in light of research needs. He also noted the multi-disciplinary nature of the AON program as a unique aspect to consider.

Dr. Stephenson also noted continuing confusion in the community about the boundaries between Arctic System Science program and the Arctic Natural Sciences programs; he suggested that there is not a fixed line between them: the system sciences program is a more strategic investment, while the natural sciences is intended to support bottom-up proposals; program staff must manage the balance between them, and communicate more clearly.

Dr. Stephenson acknowledged the issue of dwell time, noting that they have not achieved the 5-month target; some proposals are approaching 7 months, though there are reasons for each.

Dr. Dixon noted the Arctic Horizons program, through which 5 regional workshops with representatives of indigenous groups and scientists were held. He suggested the program might be a template for others to use in supporting the participation of underrepresented groups and collaborative science.

Dr. Stroeve asked how dwell time will be handled as programs moved away from proposal deadlines. Dr. Stephenson replied that the dwell time for the average proposal would likely increase; the very long dwell time associated with complex proposals should not be affected either way.

A staff member from Earth Sciences reported the dwell times decreased when deadlines were eliminated, because the workload was more even. Earth Sciences is now meeting dwell time for nearly 100 percent of proposals, with exceptions for logistical issues.

Dr. Falkner offered her thanks to everyone involved in the COVs, including COV members, chairs, and liaisons. She also thanked program staff for their efforts supporting and responding to the COVs.

Dr. Kempton moved that AC GEO accept the PLR Arctic Section COV Report; Dr. Fine seconded the motion, which passed unanimously.

Dr. Lyons moved that the minutes of the Spring AC GEO meeting be accepted; Dr. Pomponi seconded; the motion passed unanimously.

**Reproducibility in Computational Science: Framing and Steps Forward**

*Victoria Stodden, University of Illinois, Champaign-Urbana*

Dr. Hornberger introduced Dr. Stodden, who thanked AC GEO members for the opportunity to speak with them; she introduced her presentation as laying the groundwork for the discussion to follow. This presentation sought to frame reproducibility in computational science; discuss ongoing steps within the scientific community, including disciplines other than geosciences; and review strategies for the discovery and preservation of artifacts that support the scholarly record.

Dr. Stodden began by noting the impact of technology, noting that the development of enormous amounts of data and very advanced and intensive computation impact the way we think about reproducibility. Given the immersive use of computation in the vast majority of research, software carries discoveries in ways that are different than literature, or the traditional article. Dr. Stodden referenced a 1995 publication asserting: “the actual scholarship is the full software environment, code and data that produced the result.” She made two claims: (1) that virtually all published discoveries today have a computational component, and (2) there is a mismatch between the traditional scientific process and computation, which leads to reproducibility concerns.

Dr. Stodden noted different aspects of reproducibility. Empirical reproducibility refers to the more traditional sense of reproducibility. Dr. Stodden noted that empirical reproducibility is receiving press attention currently in the area of drug development; computational aspects of empirical reproducibility are not directly relevant to the current discussion.

Statistical reproducibility is affected by sample size, random or non-random sampling; claims will not reproduce if a study has low power or poor design. Dr. Stodden reported that *Science* enacted new manuscript submission requirements in January 2014, to address issues of statistical reproducibility. Manuscripts must now include a “data-handling plan” that addresses how outliers are dealt with; sample size estimation for effect size, whether samples are treated randomly, and whether the experimenter is blind to the conduct of the experiment. To assess these aspects of a manuscript, *Science* added statisticians to the Board of Reviewing Editors.

Computational reproducibility addresses how new possibilities, including massive data and massive computation interact with notion of reproducibility and how these claims can be checked. In response to a comment from Dr. Hornberger, Dr. Stodden agreed that these kinds of reproducibility do overlap; she suggested it would be valuable to hold them differently in mind for the course of her discussion, noting that considering them as separated types leads to different conclusions.

Dr. Stodden spoke to the two traditional branches of science: deductive, used in mathematics and formal logic; and empirical, which involves the statistical analyses of controlled experiments. She noted emerging discussions, over the last 10-15 years, suggesting new branches of scientific methods: large scale simulations and data driven computational science. Dr. Stodden offered examples of data-driven discovery, and statements from those asserting that these constitute new branches, but urged AC GEO members to caution in making this leap.

Dr. Stodden noted the ubiquity of error, and suggested that the central motivation of the scientific method is the rooting out of error. In deductive sciences, proofs are used to do so. The empirical branch has developed hypothesis testing, statistical methods, and the structured communication of methods and protocols to discover and eliminate errors. Donoho, et al (2009) suggest that computation and data science represent only potential additional branches of scientific method, until comparable standards for testing for error are developed. Dr. Stodden offered a third claim: that computation and data science have yet to develop these kinds of standards for assessment of claims, having only developed in the last 15-20 years, versus centuries for the other branches.

Donoho (1998) asserted that “an article about computational science in a scientific publication is not the scholarship itself, it is merely advertising of the scholarship. The actual scholarship is the complete…set of instructions [and data] which generated the figures.” Dr. Stodden noted that reproducing an investigators’ methods and coming to the same figures and tables is of less value in computational science than in other branches; re-implementing the methods through collection of additional data, or rewriting the software and methods and coming to the same answers; she suggested that these would offer more valuable scientific advances.

In considering appropriate dissemination standards, however, Dr. Stodden noted that reimplementing an entire experiment, from data collection through coding and computation, is unlikely to result in the same results, due to instability in the small decision made. The focus then turns to the reasons for differences. Without access to the original code and data, it is not possible to understand the differences between different results; it is necessary to expose the code and data underlying the claims.

Dr. Stodden reported on an AAAS/Arnold Foundation Reproducibility Workshop on Code and Modeling, held in February 2016. She noted a forthcoming policy piece to describe their recommendation. The workshop was the third in a series, and addressed code issues. Dr. Stodden noted her opinion that issues of reproducibility encompass software, data, and workflow with emphasis on any of these. She suggested that concepts such as open data should be tied back to the scholarly record.

This workshop considered ways to make code and modeling information more readily available; as these are increasingly being seen as part of the scientific record. The workshop was constructed around six panels:

1. Case studies, experimental efforts
2. Interoperability standards, proprietary codes, verification/testing: how to work with exposure of the research pipeline with propriety codes, how to think about issues like testing code (how to know that the code is working correctly). Dr. Stodden noted that in open source software, code that is contributed is delivered with tests; she suggested the same approach might be useful when software is used to develop scientific findings.
3. Licensing and facilitating re-use. Dr. Stodden remarked on that is it incredibly important that these issues be dealt with appropriately; she noted that these concerns tend to be overlooked in discussions, and that scientists have not typically had to concern themselves with licensing beyond copyright previously. Now, however, licensing travels with code, software, and other aspects of computation.
4. Incentives. Ways to incentivize the sharing of developed software through standard for credit and citation. These standards do not currently exist, and vary by community. Dr. Stodden asserted that “even the most developed are not fully developed.” This topic also addresses issues such as persistence (e.g., how to prevent links from failing when the author moves to another institution). Dr. Stodden raised the question of how these items can be made to be as persistent as an article, through digital object identifiers (DOI) other other means; she noted that these concerns also raise issues of cost.
5. Edge cases, specialized hardware, large or exceptionally complex code bases “all the hard stuff.” Dr. Stodden noted that these cases often drive the development of standards. She noted cases, such as Blue Waters, in which specialized hardware is developed; how can these be tested? She remarked that current code bases, developed over the last 20 years, were not developed for sharing; consideration of the meaning of its use or of making these codes available is needed. Again, Dr. Stodden noted the need to test and understand how software works.
6. Minimal standards for sharing. If making a computational claim, what is the minimum that colleagues must be able to access to verify your claims?

Dr. Stodden shared the recommendations of the workshop:

1. To facilitate reproducibility, share the data, software, workflows, and details of the computational environment in open repositories.
2. To enable discoverability, persistent links should appear in the published article and include a permanent identifier for data, code, and digital artifacts upon which the results depend.
3. To enable credit for shared digital scholarly objects, citation should standard practice.
4. To facilitate reuse, adequately document digital scholarly artifacts.
5. Journals should conduct a Reproducibility Check as part of the publication process and enact the TOP Standards at level 2 or 3.
6. Use Open Licensing when publishing digital scholarly objects.
7. To better enable reproducibility across the scientific enterprise, funding agencies should instigate new research programs and pilot studies.

Dr. Stodden acknowledged that these recommendations are not ready for immediate implementation; further understanding is needed, as well as strategies to address costs and other issues. She noted the presence of research aspects to these recommendations, related to stability in research results (i.e., how do underlying architectures affect model output).

Dr. Stodden presented a summary of the TOP Standards for transparency and openness, published in *Science* (June 2015). She noted that these standards do not specifically address code sharing, but that discussions of data sharing might be knit to these considerations. The TOP Standards are largely aimed at journals; about 800 have signed on to them thus far. Journals choose the level at which they will adhere to the standards.

In response to a question from Dr. Bierman, Dr. Stodden addressed pre-registration of studies. She noted that the first two AAAS/Arnold Foundation Workshops targeted the social and field sciences, and suggested that field sciences might most closely match the work done in geosciences. She offered an example of what might happen if a study is not pre-registered. An investigator might be interested in some phenomena in economics, related perhaps to wage rates. He or she begins to collect data, and to fit models onto them; if the study is not pre-registered, there is the temptation to keep testing models until one is discovered that “looks good.” Dr. Stodden noted that the significance of each test is undermined with each subsequent test; if 100 models are tested, 5 might show a signal—but 95 will not. If the 5 are published and the 95 are not included, the study will not replicate.

The concept of pre-registration is that investigators must decide what tests they will use, in advance of the study; they are allowed one test on the hypothesis that is registered, rather than being able to “play with” their hypothesis.

Dr. Bierman replied that geoscientists “go out and measure things and then go searching for connections and relationships.” He noted that some aspects of these sciences are still in the stage of mapping, trying to find relationships between aspects. He asked Dr. Stodden to clarify if she was calling for hypotheses to be laid out in advance. Dr. Stodden replied that she was; she called the model Dr. Bierman described as “Linnean science,” which she contrasted to inferential, model-building, or predictive science.

Dr. Stodden suggested that Dr. Bierman might be describing a new area of research. She offered a situation in which an investigator is fitting a very complicated model, and does not know if particular data should be included. Dr. Stodden suggested the analogy of tuning, and remarked that this kind of exploration goes to the reliability and stability of a model.

Returning to her presentation, Dr. Stodden reported that she was encouraged by the convergence of two trends: scientific projects becoming massively more computing intensive, and scientific computing becoming dramatically more transparent. She suggested these trends might reinforce one another: better transparency will allow investigators to run more ambitious computational experiments, and improved computational experiment infrastructure will allow more transparency.

Dr. Stodden outlined some of the problems facing researchers: more computationally intensive work is being done, with data from many sources, integrated in ad hoc ways through decisions that are not necessarily captured in the workflow. There is widespread use of jerry-rigged collections of clod and web services, and action taken on data are not recorded. As a result, publication of data as prescribed by the data management plan does not enable reproducibility of the associated claims.

Dr. Stodden noted ongoing efforts to address these concerns, including a 5-year grant from the Advanced Cyberinfrastructure and Science Directorate, awarded to five institutions, on Merging Science and Cyberinfrastructure Pathways. Other efforts include the Association for Computing Machinery’s development of badges to signify the level of data artifact availability in journal articles. The badge definitions denote repeatability—the same people repeating the same work; replicability—different people doing the same work, coming to the same results; and reproducibility—different people doing different work supporting the same claim.

Dr. Stodden concluding by noting that computation is near-ubiquitous in modern research, and issues of reproducibility travel with all computational research. Solutions will involve tools, cyberinfrastructure support, collaboration with stakeholders, journal and agency policy, and cultural steps. She opened the floor for discussion.

Discussion. Dr. Constable noted an initiative through EarthCube to describe the “paper of the future<” and asked Dr. Stodden if she envisioned a further in which all papers are available online, and published analyses could be re-executed; she noted that re-execution of large complex data, such a climate models, is inconceivable.

Dr. Stodden began by stating that some aspects of reproducibility are easier in some disciplines than in others. Some technologies enable embedding, but computations that require weeks on a supercomputer cannot be repeated with a click. She suggested there might be pieces that could be re-executed, or smaller tests, developed by the researcher, that support the model. Another option is 3rd-party certification, in which an outside body reruns the code once, to support belief in its conclusions.

A member of AC GEO asked about the implications for science education. Dr. Stodden acknowledged that science education was not addressed in the AAAS recommendation; she reported that it is discussed in the article. She reported that younger researchers are shocked at the lack of standards, and at the lack of mentoring in this area; in addition, younger researchers are aware of and willing to discuss the tension between open source publication and the desire for personal advancement.

Dr. Shepson asked about the extent to which the workshops discussed the “temporal responsibility.” He noted that models and platforms are evolving and the costs of having re-operable code is growing. He asked about discussions of appropriate time scales, and the responsibility for maintaining code to these scales. Dr. Stodden noted this an area for future research. She also remarked on cases in which established codes are used, current models that are still in Fortran. She noted receiving questions such as “Since my codes won’t run next year anyway, why should I bother sharing?” Dr. Stodden reported making the argument for the value of inspecting the code; and the influence of the assumption that one’s code will be open and might be inspected.

Dr. Hornberger noted that every country with a high-level radioactive waste disposal program developed code; a project on cross-comparison explored the reliability of the different models. Dr. Stodden noted that the example offered a model of using similar implementations to reinforce original models. She noted this process requires an understanding of locations of uncertainty—whether, for example, a 2 percent difference falls within the error bounds, or demonstrates a real difference.

Dr. Hornberger offered the example of hurricane tracks, and the use of ensemble forecasts when models develop different results. Dr. Stodden suggested that such an approach averages out the different instabilities in the different models. She noted, for example, that small differences make huge differences in linear regressions, which are, as a result, very unstable. Data collection and computational systems are also sources of error and instability.

Dr. Bierman noted that Dr. Stodden, in other talks, had addressed resource limitations; he noted that replicability is rarely funded, and asked if Dr. Stodden sought to assert high standards to these kinds of science, or to scale to different problems, such as nuclear waste. Dr. Stodden agreed that publication of replications would be unlikely and that she had heard from other members of the community that it would not be particularly valuable or desired. She asserted that the availability of the materials to make replication possible is still worthwhile.

Dr. Bierman noted that the geochemical community uses a set of standards for labs to run in order to support the credibility of the lab. Dr. Stodden referenced a study in which two labs involved in breast cancer research sought to reconcile their processes for cell development, to the level that one could not tell which lab originated the cell. Two months were allocated to the process, which ultimately took 2 years. Ultimately it was discovered that one lab stirred the beaker, while the other used a centrifuge: practices no one thought to mention. She also noted a “crisis of replicability” among labs using mice to measure the psychological effects of different environments; it was discovered that the gender of the mouse handler mattered in reproducing these studies. Both cases, Dr. Stodden, noted, highlight “data” that might not be captured because it is not seen to be important. She remarked that the sixth panel at the AAAS Workshop was intended to capture these kinds of concerns.

Dr. Sullivan offered the example of Galileo inventing the telescope, noting that “replicability” required another person to have the same tool and a set of instructions; he asked how computation differed from this example. Dr. Stodden said that nothing made the examples different, but that cultural differences exist, primarily in computation not being considered an instrument, and questions arising regarding the extent of instructions that need to accompany it.

Dr. Hornberger shared a story about a colleague, who rejected the four-color problem, because there was computation involved. Dr. Stodden recognized the example, noting that it raises important questions about how much one must understand a process in order to trust its result. She suggested the example goes to the issue of testing, which explores how much needs to be understood in a traditional sense in order to trust computational results.

Dr. Stodden noted the earlier AC GEO discussion of broader impacts, and remarked that much of the current discussion applies, as it addresses access for others.

Dr. Hornberger remarked on Dr. Stodden’s mention of licensing and making code available. Dr. Stodden noted GetHub as a platform for code; prior to GetHub, code.google.com was available, and prior to that, something else. She raised concerns about continued access, if investigators rely on companies that currently serve their interest, but whose core model does not include the scientific community. Dr. Hornberger noted that Elsevier and Wiley, also private companies, also publish electronic materials. Dr. Stodden suggested the geosciences are “ahead” in issues of code sharing and infrastructure, having learned from the experience of providing manuscripts to companies. As the discipline moves to codes and software, it is better able to assure that the resources remain openly available.

**Discussion: NSF “Big Ideas”**

*George Hornberger, AC GEO Chair; Roger Wakimoto, AD GEO*

Dr. Hornberger invited AC GEO members to discuss the *10 Big Ideas for Future NSF Investments*. He noted that other topics were welcome, as well. Dr. Wakimoto offered his apology for his quick overview earlier in the morning; he noted that he knew this period would be available for further discussion and exploration.

Navigating the New Arctic. Dr. Wakimoto noted that “Navigating the New Arctic” is a geo-focused big idea. He reported that the title was carefully developed, and is intended to reflect the many meanings of “navigating:” the sea, the politics, the natural resources. He noted that 10 percent of the world’s fish catch and 13 percent of the world’s oil is in the Arctic. Dr. Wakimoto noted the NSF practice of providing rapid awards in response to events like earthquakes, and suggested that the Arctic focus might be seen as a “slow rapid.” He reminded AC GEO members of his earlier remarks regarding the importance of diversity issues in the Arctic, and noted that indigenous people must help NSF define the research agenda, be involved, and may help collect information.

Dr. Wakimoto noted at least six recent National Academies reports highlighting the importance of the Arctic; he suggested these reflect the place of the Arctic among the priorities of the community.

Dr. Constable noted that the COV report raised concern about mortgaging the focus, and asked if Dr. Wakimoto anticipated increased funding for the Arctic, and if so, whether that funding might come through GEO. Dr. Wakimoto replied that the development of the 10 Big Ideas was intended to serve as a budget builder for the foundation, by articulating a compelling research agenda. He noted that the NSF tends to be more conservative than other agencies in asserting what it should be doing; it will be interesting to see how the 10 Big Ideas play out in the coming months and years.

Dr. Stroeve noted the emphasis on Arctic observing, including in other countries. She asked about plans for international collaboration. Dr. Wakimoto replied that “navigating the community” might be another way of interpreting the title. He acknowledged that the NSF might serve as the lead agency for Arctic observation efforts, but the foundation cannot conduct these efforts without the involvement of the international community and other agencies. He noted that commitments from other agencies and countries were offered at the White House ministerial on the Arctic.

Dr. Sullivan asked about the time scale or plan for moving forward on Navigating the New Arctic. Dr. Wakimoto said there were no specific plans in place; the intention was to identify the big ideas and allow the ideas and plans to emerge. The ideas are now being refined and strategies for engaging the community developed. Dr. Wakimoto stated that he would be attending the AGU, with the intention of encouraging community involvement.

Dr. Sullivan asked for confirmation that discussions were occurring “up and down the line.” He also noted that “Windows on the Universe” also included a GEO component. Dr. Wakimoto confirmed broad involvement, and GEO engagement and interest in other Big Ideas, including the Rules of Life; he noted the presence of GEO representation on the other Big Ideas committees.

Dr. Kempton noted the recent International Polar Year, and the work conduced at that time, developing connections. She asked if these were still active, or would need to be reinvented. Dr. Stephenson reported that connections made during the Polar Year are still very active in the research community. The Polar Year provided a step in establishing these connections, Dr. Stephenson agreed; the projects are not possible without working in and with other countries. He noted that, institutionally, efforts to develop new connections will be made; the agency-to-agency connections were not as strong during the Polar Year.

Dr. Semeter noted that “one could argue there’s nothing more important than understanding the history and future of habitability of our planet.” He why climate change was not included in the big ideas. Dr. Wakimoto replied that one of the criteria for the big ideas was their uniqueness to NSF, and that the NSF could not “own” climate change in the same way it could own Arctic research. He noted that climate change science encompasses an “incredibly broad agenda,” and that several big ideas include targeted efforts focused on climate change. He suggested that the New Arctic offers a targeted, focused way to address it.

Dr. Semeter suggested that data science was being led by Google and Facebook, that there was an argument to be made that NSF does not own data science, either. Dr. Stodden stated that she disagreed with the premise regarding data science, noting that the companies mentioned are leading in areas other than science. She noted that data science is evolving, and that NSF will make or influence some of the decisions that will shape this evolution.

Dr. Arroyo noted that much of the work her institution does is applies, and is conducted with communities that are seeing changes in their environment. She stated her perception that many of these communities are struggling to understand how best to rebuild in the face of climate change. She noted the relative paucity of agencies focused on adaptation rather than mitigation or clean agency; she described the “real gap” as down-scaling the data NSF has gathered, and making it accessible and usable to those who need to put it into use. She asked about the role NSF might play in addressing this gap.

Dr. Wakimoto noted that the big ideas represent only a small fraction of the NSF budget (approximately 8 percent). Across the foundation, more than $300 million is committed to climate research, much of that within GEO. He asserted that NSF is not turning away from climate change research, in fact, the NSF commitment is second only to NASA. He noted that the big ideas represent important agenda items for the foundation, but are only a small fraction of the portfolio.

Dr. Hornberger reported that he and been involved in a committee discussion on translational research, a term used in medicine for getting the findings to the people who need them. He noted that the NSF does not typically address these issues. Dr. Wakimoto countered that “translational research” would have to be a piece of the puzzle in the Arctic, and noted the indigenous people would be setting the research agenda.

Dr. Voorhees asked by Improving Undergraduate STEM Education (IUSE) was not part of Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers In Engineering and Science (INCLUDES). Dr. Wakimoto remarked that IUSE targets the undergraduate audience, and said there would be overlap between IUSE and INCLUDES. He noted the NSF has invested more than $700 million in broadening participation, but hasn’t “moved the needle” much. INCLUDES is an effort to step back and determine what the problems are, and why successful programs have not been successfully scaled up. INCLUDES is an attempt to scale small successes, to move the needle substantially, perhaps without significant new investments.

Dr. Pomponi asked how other Assistant Directors (ADs) see the big ideas developing over the next months and years, whether investments will be made separately or across directorates. Dr. Wakimoto noted that another consideration is the possibility other named projects might disappear; he noted that the ADs are considering all possibilities. Dr. Wakimoto asserted that all the big ideas are cross-directorate efforts; a newly convened steering committee for the New Arctic includes representation from all directorates. He noted that he could not say how the big ideas would actually play out; INFUSE or Risk and Resilience might serve as models, but this is not yet known.

Dr. Pomponi asked Dr. Hornberger to speak to the role the AC might play in advancing the big ideas; Dr. Hornberger replied that the AC would be asked to comment for GEO as plans advance. In addition, the AC meets with the Director occasionally, and can develop a letter to the Director if they have specific advice.

Dr. Dixon agreed that the big ideas were “marvelously interdisciplinary,” and noted that these kinds of efforts can be challenging to administer. He asked if persons with expertise in administrative concepts and structures were involved. Dr. Wakimoto agreed this expertise would be a good addition; he stated that NSF is also considering whether the 10 big ideas should be unveiled at once or rolled out in batches. He reported that discussion on administering these efforts had begun, but that decisions had not yet been finalized; Dr. Dixon suggested that the ideas might best be released in batches of 5, rather than 10 at once. He clarified that his question focused on administering the efforts. Dr. Wakimoto replied the administration would not be very different from that of the cross-directorate initiatives. He noted that the Science, Engineering and Education for Sustainability (SEES) initiative was the largest to data, and led to a painful learning curve; Dr. Wakimoto suggested the NSF was “beyond that now.”

Dr. Falkner noted that the NSF is aware of the need to invest in the area of the New Arctic, and has existing competitions that would welcome projects which would logically fall within that structure. She offered the Major Research Instrumentation Program as an example. Dr. Falkner suggested the NSF might make this alignment known to the larger community, and invite projects that would contribute to the New Artic.

IPA Program review. Dr. Hornberger noted the ongoing discussion of the use of IPAs at NSF. NSF has place high emphasis on maintaining a pool of people who rotate through, but questions about whether it is cost-effective have been raised. Dr. Wakimoto replied that the issue of cost-effectiveness was somewhat misleading; the cost-difference is small in proportion to the entire budget. Dr. Wakimoto suggested that issues of institutional members, the effort required for search committees, and the potential blocking of promotion for internal staff were more salient.

On the other hand, Dr. Wakimoto noted, the IPA program brings a wealth of scientific expertise to the NSF that would be difficult to develop otherwise; the relationships developed between the academies and NSF are also valuable. Dr. Wakimoto asserted the NSF is a special organization because of the IPA program. He reported that federal employees remark on the flexibility of the NSF, while academic personnel remark on it bureaucracy; Dr. Wakimoto suggested the IPA program allows the NSF to operate in a middle way.

Dr. Wakimoto acknowledged some faults in the operation of the IPA program, including the absence of a workforce management plan. He noted questions such as whether ADs should be all IPAs or all federal employees, or some mix of the two, and if a mix, what mix. No formal decisions regarding the optimal number of IPAs has been made. Dr. Wakimoto reported that working groups had been convened to address these and other questions that had never been asked or answered previously. He noted his support of the process, and said that reports would be finished soon. He shared his expectations that nothing “draconian” would be recommended.

Dr. Stodden noted one of the values of bringing in people from the external community that it supports NSF’s leadership role in the external community, and help to maintain NSF’s place as the premier funding agency. She asserted that this close relationship with the community directly supports accelerating scientific discovery.

Dr. Hornberger noted his impression that the cost of the program was a concern. Dr. Wakimoto acknowledged that cost was raised as a concern, but that the cost was relatively small (a few million dollars). These costs are largely salary, as university faculty have a higher salary than federal employees. Dr. Bierman asked if the higher salary was due to the recruitment of senior academics; Dr. Wakimoto agreed it was, at the AD level.

Dr. Hornberger noted that all the AC GEO members had colleagues who had served as program officers; he noted such familiarity affects the way the community thinks about the NSF. Dr. Wakimoto agreed, noting that IPAs tend to return to the community and serve as great ambassadors for the NSF. He said he could think of no better way of developing this kind of support.

Convergent Research. Dr. Stodden asked Dr. Wakimoto to comment on the Convergent Research big idea, noting that she found it interesting it was pulled out as a separate topic. Dr. Wakimoto remarked that some people had asked why the term was “convergence” rather than “interdisciplinary,” and noted that differences between the concepts exist. The Director, he reported, feels that the NSF has not been very effective in interdisciplinary research. A typical example is an interdisciplinary project in which social scientists are invited to join after the project has been framed.

Convergence research, Dr. Wakimoto explained, characteristically seek the development of shared research goals among an interdisciplinary team from the very beginning. He noted that this could be difficult to do. Dr. Wakimoto described convergence research as setting a higher bar.

Dr. Hornberger noted a reference to requiring up to a year for researchers to “converge” on shared research agenda; he noted that Stanford needed 4 years to develop a convergence research agenda.

Mid-scale Research Infrastructure. Dr. Hornberger noted that Dr. Wakimoto had remarked on mid-scale infrastructure, and remarked that previous reported had identified the MRI project as one scale, with MREFC on another scale, with nothing in-between.

Dr. Wakimoto agreed that this gap was an issue; he noted that the realignment of the PLR division into GE raised the directorate budget, increasing the gap between MREFC, which is comprises 10 percent of the directorate budget ($130 million), and MRI, which has a maximum of $4 million. Dr. Wakimoto spoke to this size of this gap, and “report after report after report” about important research to be undertaken at the mid-scale; he spoke to the hope that another source of such funding might be developed. In addition, Dr. Wakimoto spoke to the possibility that such an effort might be more egalitarian, and could open doors for other directorates; He noted that supercomputers in engineering, for example, would fall into this scale.

Dr. Sullivan asked about how the information on the big ideas would be marketed. Dr. Wakimoto replied that OLPA asks this question every day. He agreed that it would be challenging to approach a research agenda in this new way, especially while assuring that community input continues to shape its development.

**Update on GEO Education Activities**

*Brandon Jones, AD/GEO*

Dr. Jones thanked the AC GEO for the invitation to speak with them, and for waiting for the Fall meeting—after he’d had more time in his position—to request the presentation. He offered a short review of his history, noting that he had studied at the Lincoln University and the University of Delaware. He taught high school in Prince Georges County, Maryland for five years, then took a PhD from University of Delaware. After receiving this degree, Dr. Jones worked at the Environmental Protection Agency (EPA), National Center for Environmental Research. IN 2009, he took over the higher education fellowships at EPA, and came to NSF in March 2016.

During his time at EPA, Dr. Jones served as agency representative to the 2013 CoSTEM Strategic Plan, which led to a realignment of STEM assets across the federal government. NSF was assigned the for undergraduate and graduate sectors in STEM. Teacher preparation programs and others were realigned to the Department of Education. Dr. Jones noted some dissatisfaction within agencies which saw their fellowship programs sunset.

Dr. Jones reviewed the scope of his presentation, which would discuss how the GEO Education and Development (E&D) Portfolio connects externally, its internal programs, and related activities.

Dr. Jones offered INCLUDES as an example of programs by which GEO connects externally. GEO supports applications with a geo-focus, and, in a spirit of supporting diversity efforts across NSF as a whole, projects that are not solely geo-focused. Dr. Jones described a project at Carleton College which sought to develop regional partnership that could create pathways for students and community to consider geoscience projects of local interest. This project had an emphasis on service learning and community engagement.

Dr. Jones noted that most of GEO’s collaborations occur with Education and Human Resources (HER); a DCL in FY16 generated more than 100 supplement submissions, resulting in nearly 100 inquiries for Early-concept Grants for Exploratory Research, 40 of which were invited to submit proposals. Seventeen EAGERs and 92 supplements were recommended for award; 70 supplements were received by the Historically Black Colleges and University Undergraduate Program (HBCU-UP). Dr. Jones noted that GEO’s share of the funding was disproportionate to the number of proposals; GEO co-funded HBCU-UP supplements focused on research capacity for faculty, including some not limited to GEO disciplines. He noted that few HBCU’s have GEO-related programs and departments.

Another DCL was released for FY17, encouraging submissions by HBCU’s; if the response is light, the next phase will encourage supplements and EAGER submissions, as before. Dr. Jones noted that he is encouraged by discussions of a virtual sponsored research office (SRO), which would be managed by the Office of Integrative Activities. Additional Research Experience for Undergraduates (REUs) at HBCUs are also under discussion; there are currently 3 REUs at HBCUs.

Another suggestion is to bring HBCU PIs to NSF for a meeting; Dr. Jones noted that many of these PIs are intellectually isolated, and the NSF might support the building of a community among them. Bringing underrepresented undergraduate faculty from majority institutions, who may be socially isolated, to this meeting is being considered, as is adding HBCUs to supplement requests, in order to encourage connections between HBCUs and underrepresented faculty.

The Pathways in Geospace (PAGE) program provides a connection between GEO and tribal colleges. The PAGE program encourages collaboration between non-tribal and tribal institutions; PAGE provides support to the collaborating non-tribal institution while the Tribal Colleges and Universities (TCUP) program funds the tribal institution. Representatives from GEO attend meetings of the Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS) and the American Indian Science and Engineering Society (AISES), in order to build relationships and inform the community of these opportunities.

The Graduate Research Internship Program (GRIP), which originally only addressed Graduate Research Fellows, is now expanding its pool to include submissions from graduate students on regular awards. In FY16, three graduate students received awards, one in ocean science through the National Oceanic and Atmospheric Administration (NOAA). Other directorates are currently considering this model.

Internal education efforts include the GEOPATHS program, which is designed and managed within GEO but connects to the IUSE program. Tracks include EXTRA, which supports student experiences in geosciences, and IMPACT, which focuses on sealing the transitional points from high school through undergraduate education. Dr. Jones noted that the current solicitation closed on the 11th of October; 83 submissions were received. Panels will convene in late November or early December; 10 awards in each of the two tracks are planned.

Dr. Jones reported that funding for the REU program has decreased since 2015, but is level for GEO REU; there are currently 60 active sites, supporting approximately 600 positions. In 2015-16, the gender breakdown within REUs was reviewed; there was an overall decline in participants, compared to previous years, and male participation is significantly lower. Among underrepresented groups in the GEO REUs, African Americans show a steady downward trend in participation.

Dr. Jones reported that the Geoscience Opportunities for Leadership in Diversity (GOLD) program was inspired by the INCLUDES effort and is intended to cultivate “diversity champions” within GEO by providing leadership and professional development. An ideas lab process was used to generate six collaborative projects, one of which was encouraged to submit to INCLUDES. The GOLD awards will be announced soon; a planning meeting for all PIs will be held at NSF in December.

GEO supports the international Global Learning and Observation to Benefit the Environment (GLOBE) program, led by NASA with participation from NSF and NOAA, through supporting research scientists to expand the GLOBE network and connect to science teachers and promote the GLOBE protocols. GEO also supports supplements, including one for the translation of materials from science fairs into other languages. NSF support the annual meetings of GLOBE; the next will be held in New Haven, Connecticut in 2017.

Dr. Jones reported on outreach and related activities by GEO, noting that many focused on diversity. These include outreach to the National Association of Black Geoscientists (NABG), the National Technological Association, and a AGU Harassment Workshop. Dr. Jones noted that the AGU workshop will result in a publication to be distributed to members. Dr. Jones reported that an effort to analyze the future of undergraduate GEO with members of the community was moving into its final phases, and would result in outputs, yet to be determined. In the Spring, the GEO education program would focus on professional society meetings.

A COV will be convened in Spring 2017; GEOPATHS, GOLD, GLOBE and Polar Education programs will be evaluated. Dr. Jones noted that he was seeking volunteers for this COV, which would include 5-6 members. Dr. Fuentes and Mr. Voorhees volunteered.

The strategic plan for GEO’s education and diversity programs ended. Rather than developing a new plan, the program will conduct a retrospective analysis. Staff are working with the OIA Evaluation and Assessment Capability (EAC), and have convened a working group for a 1-year process. The audiences for this evaluation include the GEO directorate and AC, GEO E&D Programs, the GEO community, and other disciplines; the working group is seeking ways to increase the importance of these efforts to decision-makers.

The statement of work and independent government cost estimate (IGCE) have been completed; contracting can be fast-tracked, since this is an internal evaluation only. Dr. Jones reported that the process is scheduled for completion in late summer 2017, in time to inform strategic planning for the following budget year.

The purposes of the evaluation are to consider the return on investment (ROI) of the programs, where impact has been made, efforts to educate teachers and to infiltrate underrepresented communities. Three focus areas are: to what extent have GEO E&D programs met their goals, what is the value added, and how will the information be used?

The evaluation of goals will include a review of what has been done, opportunities for synergy within and beyond NSF, management and measurement best practices, and necessary changes. Evaluation of the value added by E&D will consider service learning and the societal relevance of GEO, as well as broader impacts and GEO training. This information will be used for internal programming within GEO E&D, planning by the Division Director and Directorate and decisions regarding the allocation of funds, and for dissemination of evidence for the ROI and best practices to the GEO community.

Dr. Jones opened the floor for discussion.

Discussion. Dr. Voorhees reported that he was looking forward to the evaluation report, noting that he believed E&D to have been a good program.

Dr. Voorhees noted an increase in Hispanics in REUs and asked if Dr. Jones could speak to the reasons. He suggested these might be leveraged to other Hispanic-serving Institutions (HSIs). Lina Patino, EAR Program Director, replied that demographics are one of the factors for the increase; REUs are located in States with increasing Hispanic populations. She noted that some sites are specifically recruiting within the Hispanic community, but suggested that demographics play the larger role.

Dr. Voorhees asked for more detail regarding plans to bring HBCU PIs together; he suggested this model might also be used with Hispanic PIs. He noted that he teaches at a school with a large Hispanic population and would welcome any lessons learned regarding outreach. Dr. Patino replied that bringing Hispanic PIs together was under discussion, as well as distributing lessons learned by PIs regarding outreach.

Dr. Fuentes asked why only 3 REUs were located in HBCUs; he also asked about HSIs, and what efforts in GEO might translate the success stories into greater numbers of proposals submitted and funded. Dr. Jones replied that, in discussions with HBCUs, it had been noted that many are involved in agricultural research because of their history; some of this work translates to GEO, and discussions are ongoing to increase the awareness of the GEO-related research ongoing at HBCUs. Currently, much of this research is funded by USDA; few HBCU’s look to NSF for funding. Dr. Jones noted efforts to make this connection. Dr. Patino noted that REU programs are located at HSIs and Tribal sites. She also noted that GEOPATHS supports PIs to provide research opportunities to their own students.

Dr. Hornberger remarked on the challenge of taking successful diversity programs “to scale,” noting that great programs, such as a collaboration in astrophysics between Vanderbilt and Fisk, tend to be local. He suggested that the only way to replicate these successes might be to “clone their leaders,” and asked if the goal of the GOLD program was similar. Dr. Jones replied that it was; the GOLD program is focused on seeking ways to go to scale. He noted the tribal colleges and HBCUS tend to be disconnected; the E&D program is looking to address this issues, and to gain insight from their evaluation. The program seeks to facilitate the development of a scaffold on which a communication network can be built.

Dr. Van Dover remarked that majority faculty and PIs at majority institutions sometimes struggle to make connections to students from underrepresented groups. She asked if Dr. Jones felt these faculty to build connections to HBCUs, or if he had other ideas for connecting students from underrepresented groups and majority PIs.

Dr. Jones replied that he did not have a formula or answer; he offered to speak offline about strategies adopted by Duke University.

Dr. Van Dover asked if there were ways to inform HBCUs with REU program about other GEO programs to which they might refer applicants, if they receive too many to accept. Dr. Jones replied that this suggestion aligns with plans for increased participation and communication. Dr. Cavanaugh noted that, in chemistry, there were efforts to widely inform the community of all the REU sites, how to contact them, and their deadlines. She suggested the same might be done in GEO, though she noted she did not know how successful such efforts were.

Dr. Fuentes reported that NSF and the National Association of Academies of Sciences have information on all the REUs. Dr. Van Dover asked if he believed qualified underrepresented students were turned away. Dr. Fuentes replied that it was very common for students who aren’t accepted at one program to be referred to another. Dr. Jones noted that this practice was related to issues about increasing awareness of REUs and showing the relevance of GEO in underrepresented communities.

Dr. Jones added that generational diversity is an aspect of diversity in general. He noted that current students tended to be anti-tradition, and seek to answer questions of what they want to *do* rather than what they want to *be*. He suggested these students “don’t see the point in a discipline if they don’t see how to apply it.”

Dr. Voorhees reported that he is working on a change agents program to make demonstrate how geosciences can be a career. Dr. Jones agreed that such efforts were important, and other, similar efforts. He reported on programs to educate students on geosciences activities in their areas, and how these activities might impact their communities; Dr. Jones noted that many impacts are disproportionately impacting underrepresented communities.

Dr. Arroyo asked if support is available for underrepresented students to attend national conferences. Dr. Patino replied that there was; in fact, students planning to attend SACNAS also receive funding to attend the Geological Society of America (GSA) annual meeting; GSA has a donor-funded program, “On to the Future,” which provides this support, and connects students to mentors. Dr. Jones noted that societies provide support with meeting costs; NSF can provide travel funds. Dr. Voorhees reported that two of his students were “profoundly impacted” by their involvement in the On to the Future Program.

Dr. Fine reported that she had her first black undergraduate student in her marine sciences program; the student is a first year undergraduate. Dr. Fine noted that students cannot apply to the Scholarship Opportunities for Academic Recognition (SOAR) program. Dr. Jones and Dr. Patino encouraged Dr. Fine to support her student to attend diversity oriented professional meetings, and to attend herself. Dr. Jones noted a long-standing program at Hampton University, which connects underrepresented undergraduate programs to mentors and AGU.

**Preparation for Meeting with the NSF Director & Chief Operating Officer**

Dr. Hornberger facilitated a discussion among AC GEO members, regarding topics they wished to raise in their upcoming meeting with the NSF Director and Chief Operating Officer.

**Meeting with the NSF Director & Chief Operating Officer**

*France Córdova, Director, Richard Buckius, Chief Operating Officer, NSF & George Hornberger, AC GEO*

Dr. Hornberger welcomed Dr. Córdova and Mr. Buckius, and invited any opening comments. Dr. Córdova thanked AC GEO for making the time for discussion; she noted that it was late in the day, and immediately opened the floor for discussion.

Dr. Fine asked how Dr. Córdova imagined the relationship between the NSF’s 10 Big Ideas and its funding of individual PIs. Dr. Córdova replied that each of the big ideas are a mix of “top down” and “bottom up” ideas; the developed out of the work that NSF is already doing, although, she noted, they had not yet received the level of investment that would allow them to “really open up to new levels.”

Dr. Fine asked how Dr. Córdova envisioned NSF proceeding on the big ideas; Dr. Córdova noted that the current budget is flat. As the NSF developed its FY18 and FY19 budgets, two kinds of planning are underway: in the near time, in a flat-budget scenario, considering how to balance current activities with the ability to go more deeply into the big ideas, perhaps through leveraging industry, foundations, or other sources. The other framework takes seriously Newt Gingrinch’s idea to double the NSF budget; if funding increased significantly, how would the big ideas and other activities be funded? Dr. Córdova noted that increased funding would also be used to build the NSF’s core, and to increase staffing. By working on these different budget scenarios simultaneously, NSF hopes to engage Congress, private foundations, and others to invest.

Dr. Voorhees noted that the AC GEO had heard about the big ideas, and from Dr. Jones during the current meeting; he asked how any single big idea—such as INCLUDES—might be prioritized, given the current budget pressure. Dr. Córdova noted that she had been asked which big idea she would choose, if she had to choose only one, and that she had replied, “INCLUDES.” Her reasoning is that an increase in the talent pool will eventually grow all other aspects.

Dr. Bierman asked Dr. Córdova to share her thoughts about the current relationship between Congress and the NSF. Dr. Córdova replied that she felt the relationship was “strong for the times;” she also noted that the times were changing. She commended the new leadership of OLPA, and noted that OLPA staff and other NSF representatives have spent a lot of time in communication with Congress, and that she felt this effort was paying off. She noted, for example, that directorate-level funding was eliminated from the current budget, and that no funding was lost. Dr. Córdova noted that these successes were due to work with the science community, and the community’s outreach on behalf of all scientists.

Dr. Córdova also offered the example of universities hosting 6-8 Representatives at a time, to have breakfast or lunch with Dr. Córdova and discuss the work of the NSF. She invited AC GEO members to consider hosting such an event, and encouraging colleagues to do the same, noting that the discussion could be focused on State-specific information. The events have been held in the States themselves, and in the District of Columbia; Dr. Córdova said they tended to be more effective in DC, because it is easier for people to attend. State events can be scheduled to coordinate with events in the area which Congressional delegates would also attend.

Dr. Bierman asked what the AC could do to assist with Congressional relations. Dr. Córdova remarked that any university development office would describe it as “a sport that requires constant attention.” She noted that staff and commitment membership change frequently. She suggested AC GEO members might develop consistent messaging regarding the importance of Federal funding for science, to prime the pump of discovery. She also suggested members bring something they might leave with a staffer or Congressional representative: a photograph, for example, of someone who made a significant discovery. She encouraged members to treat staff just as they would treat a Representative; she noted that staff are smart and up-to-date with legislation, that they often draft legislation, and that visits with staff are very worthwhile. Dr. Córdova noted that “clarifying the message” is the most important aspect of this effort.

Dr. Córdova noted that, when a professor at Santa Barbara won the Nobel Prize, no one in the press made the connection between that achievement and the funding that supported the individual. She suggested messaging making that connection is valuable.

Dr. Prather remarked on conversations about better relaying the successes and broader impacts of geosciences work; she noted that one of the greatest successes has been in advancing the understanding of climate change, and this topic can be “delicate.” Dr. Córdova replied that the challenge of the conversation can depend on circumstance; she noted that 10 Congressional Representatives traveled to Antarctica to meet with researchers there. Although much of the research was related to climate change, “we did not put up that banner.” Researchers spoke with Representatives about their specific work, and the legislators themselves made the connections. Dr. Córdova encouraged AC GEO members to “begin with what you love, what you have a passion about,” rather than beginning with the language that is known to be controversial.

As another example, she noted that universities are vibrant and interesting places in which scholars and students are doing great work. Rather than inviting a Congressmen to a talk on climate change, that Representative might be inviting to hear students discuss the work they are doing in atmosphere sciences. Dr. Córdova also remarked that she makes the point that NSF is not a regulatory agency; NSF conducts research, so that the those who make regulation know as much as they can about the situations they are addressing.

Dr. Prather offered her thanks to the NSF for the speed with which they had responded to the Oceans Report, including recommendations to balance the funding. Dr. Córdova replied that the fast response was due to Dr. Wakimoto and other Division leaders; she noted that the board was very enthusiastic about the report. Dr. Córdova noted the great value of these kind of reports, which serve as blueprints based on broad consensus and deep buy-in, which is then reported by the press. Dr. Córdova noted that Congress also appreciates these reports, which have become more sophisticated over time. She expressed her desire to have them for every discipline.

Dr. Buckius described the Oceans Report as one of the best he had ever read; he noted that it offered content with clear justification, which is helpful to all who must make decisions from it. Dr. Prather said she would pass his comments along to members of the former committee.

Dr. Fuentes asked about expectations for the new NSF budget; Dr. Córdova replied that she is expecting a flat or higher than flat budget in the coming year.

Dr. Hornberger asked Dr. Córdova to share her thoughts on the right mix of IPAs within the NSF. Dr. Córdova began by noting that the IPA is extremely valuable to the NSF. She recognized that “people poke at the program” periodically, and suggested that this was one of those times. Management of the IPA Program was identified as one of the top 10 challenges by the Office of Inspector General last year; Dr. Buckius has testified to Congress on the program.

Dr. Córdova remarked on the importance of finding the right balance, and the decision to undertake a full review of the program to that end. The head of the Office of Information and Resource Management convened a Steering Committee, which has considered several questions about the IPA Program over the last few months; the Steering Committee made a report to the Board in August.

The Steering Committee made a number of observations, and gathered significant data about the IPA Program into their report. The Steering Committee suggested three task forces, to consider: (1) the appropriate balance of IPA and Federal employees within NSF; (2) the most appropriate hiring authority model; and (3) cost considerations. The task force on costs is nearly complete, and will release their recommendations soon. Dr. Córdova asserted that the NSF does not seek to weaken the program, but to answer concerns and to act as good stewards.

Dr. Buckius noted that the NSF has approximately 1,300 employees and 135 IPAs. He remarked that the NSF does not conduct research, and that direct research experience is one of the values the IPAs bring. The Federal employees, he noted, are the foundation of the NSF, and issues such as stability must be considered.

Dr. Lyons asked Dr. Córdova to share her perspective on the Arctic ministerial, which she co-chaired. Dr. Córdova remarked that she was gaining greater appreciation for the importance of ministerials. Secretary of State John Kerry is currently serving as Chair of the International Arctic Council, a position that rotates among the eight Arctic nations. Given his position, it was appropriate for the U.S. to host the ministerial this year; ministers from many countries attended. The ministerial divided issues of concerns into four areas, one of which was science.

Dr. Córdova served as co-chair of the science area, with her Russian colleague. Country representatives made statements of their concerns and interests; Dr. Córdova reported that the importance of the Polar Program was underscored by the NSF presence and role.

Dr. Córdova remarked that the ministerial provided an opportunity for reflection on the importance of the Arctic; nations that do not geographically touch the Arctic sent representatives to express their interest. She noted that, out of the understanding of climate change comes that understanding that events in the Arctic do not only impact the Arctic. Dr. Córdova remarked that speakers only have a few minutes to offer their remarks, but that the most important statement may be made by their presence, asserting that the topic is of importance to their country.

Dr. Córdova remarked that she had not previously realized the research resources in the Arctic—the number of ships and underwater drones and other resources; the synthesis from the ministerial is that data and assets would be shared, and the countries would seek to engage in more collaborative efforts.

Dr. Lyons asked if Dr. Córdova could speak to the potential realignment of the Polar Program from GEO; Dr. Córdova reported that the committee has made its recommendations, and that she had reviewed all the comments received. She stated that decisions were being finalized, and would be shared with the Board in early November; after that meeting, the approach would be shared with the community. Dr. Buckius reported that he had also read all the comments submitted.

Dr. Córdova noted that concerns were focused on management, budget, and leadership of the program. Budget concerns were related to protecting funding for Polar Programs, and management concerns to assuring the best management possible. The Polar Programs are complex, and have significant logistic and travel complications; the goal is to assure these details are addressed well. Leadership concerns are related to assures that the Polar Programs have the visibility they should have on the international stage, given the importance of the Arctic and the Antarctic. Dr. Córdova noted that rapid change is impacting citizens of the Arctic and the entire Arctic system. The goal of this review is to develop a model that addresses these concerns.

Dr. Semeter noted the President’s recent Executive Order on preparedness for space weather, and asked how NSF is responding. Dr. Córdova replied that she and Dr. Buckius would be very involved in working with other agencies to develop their response. She noted the upcoming launch of the Daniel K. Inouye Solar Telescope (DKIST), as well as other telescopes managed by NASA; the goal is to determine how best to coordinate these efforts.

Dr. Dixon noted that the 10 Big Ideas are very multi-disciplinary; he asked Dr. Córdova to comment on the challenges of administering such a large suite of complex initiatives. Dr. Córdova replied that the 10 Big Ideas provide an invitation to change some of the ways tings have been done; she noted that NSF has some strong processes, but not all will be applicable to all of these ideas. Convergence, for example, will call for new types of funding.

Dr. Córdova asserted that the first task is to build excitement about the 10 Big Ideas; then to develop the investment, which will support the people, and so on. She agreed that there were many moving parts, but noted that NSF is a large and complex agency to begin with. She shared her hope that these ideas would help to build the perception of NSF as an agency rich with opportunity, and so would attract personnel, particularly as the NSF moves to Alexandria.

Dr. Buckius noted the budget goal of $1 billion per year for 7 years, to advance these ideas. If that funding is received, the NSF would staff up; if not, he asserted, more staff are still needed. Dr. Buckius asserted that the big ideas must be addressed, and that community realizes their importance. The focus on interdisciplinary research will require new ways of doing things; he noted that it is currently impossible to submit a proposal to NSF as a whole.

Dr. Córdova shared her imagining of a mechanism through which proposals could be assigned a merit review group and calendar, in order to reduce administrative burdens on staff. She reported on a recent Federal workforce survey that found global satisfaction to be good, but struggles with the workload. She suggested workload issues are related to the fact the 93 percent of NSF funding “goes out the door” in proposal funding, but noted that no one wanted to reduce that support.

Dr. Arroyo thanked Dr. Córdova for the time she had provided; Dr. Arroyo noted her pleasure in serving the AC GEO, and wished Dr. Córdova well in her upcoming big decisions—including the replacement for Dr. Wakimoto. Dr. Córdova thanked Dr. Arroyo for her service on AC GEO, and said an announcement regarding the new GEO AD would be forthcoming.

Dr. Hornberger reviewed the logistics for the group dinner and reminded AC GEO members that the next day’s meetings would begin with subcommittees. He adjourned the AC GEO meeting for the day.

**Meeting Adjourns for the Day**

**Thursday, October 20th**

**Division Subcommittee Meetings**

**Ocean Sciences (portion will be joint with PLR),** *Rana Fine, AC GEO; Richard Murray, Division Director, OCE*

**Polar Programs (portion will be joint with OCE),** *Berry Lyons, AC GEO; Kelly Falkner, Division Director, PLR*

**Earth Sciences,** *George Hornberger, AC GEO; Carol Frost, Division Director, Earth Sciences*

**Atmospheric & Geospace Sciences,** *Vicki Arroyo, AC GEO; Paul Shepson, Division Director, Atmospheric & Geospace Sciences*

The day began with Division Subcommittee meetings and a period for open discussion among AC GEO members. Dr. Hornberger reconvened the AC GEO at 10:45 a.m.

**Status of Revised NSF Strategic Plan**

*Stephen Meacham, Office of Integrative Activities*

Dr. Meacham thanked AC GEO for inviting him to discuss the NSF strategic planning process; he stated that he would review the process and methods for providing input. Dr. Meacham explained that Federal agencies are revising their strategic plans at the beginning of the Presidential term; for the first time, this planning is occurring government-wide. Legal requirements establish the timeline; the plans must be submitted to Congress in February 2018, with the FY19 budget.

The draft strategic plan will be submitted to the Office of Management and Budget (OMB) by May 2017; input from the various ACs is currently being sought, in order to allow their perspective and influence prior to the draft to OMB. OMB defines the process and general structure of the plan; as a result, this strategic plan may not resemble past plans.

Dr. Meacham noted that the NSF Strategic Plan will be a very high level document, identifying broad, long-term aspiration, objective and values that will help NSF achieve its mission. Dr. Meacham suggested that those who would provide input first review the current strategic plan, and provide thoughts on the key elements of that plan.

Dr. Meacham described two routes for proving input. A website is available for individual feedback (<https://www.nsf.gov/od/oia/strategicplan/feedback.jsp>); the AC might also provide feedback as a whole, via email to [strategicplan@nsf.gov](mailto:strategicplan@nsf.gov). Dr. Meacham encouraged AC GEO members to provide input within the next 3-4 weeks.

The mission of the NSF, defined in the NSF Act of 1950, is: to promote the progress of science; to advance the national health, prosperity and welfare; to secure the national defense; and for other purposes. Dr. Meacham noted that this mission is well-liked within the NSF, for addressing the priorities of those working with the agency and providing a great degree of freedom; he also noted that the mission has been well supported through the years.

Dr. Meacham then offered a series of questions that AC GEO might consider in preparing their input. He noted that AC GEO members are embedded in a wide portfolio of research and education activities; he asked what they saw changing: in the relationship of American and international sciences, or the nature of science. Dr. Meacham noted that the NSF emerged from the university structures of the 1950s and 1960s; he invited AC GEO members to consider how these are changing. Dr. Meacham asked AC GEO members to consider what elements of the current plan seem less relevant today, and what key values should be emphasized moving forward.

Dr. Meacham reviewed the key elements of the Strategic Plan: the vision, core values, strategic goals (about 2); 2-3 strategic objectives for each of the strategic goals, and management objectives. He asked AC GEO members to consider whether the vision statement from the current Strategic Plan is appropriate, and “as crisp as it could be.” The vision statement is: “A Nation that creates and exploits new concepts in science and engineering and provides global leadership in research and education.”

Dr. Meacham presented the five current core values: scientific excellence, organizational excellence, learning, inclusiveness, and accountability for public benefit. The current Strategic Plan has three strategic goals:

1. Transform the frontiers of science and engineering
2. Stimulate innovation and address societal needs through research and education
3. Excel as a Federal Science Agency.

Dr. Meacham noted that the high-level objectives defined for each strategic goal define what NSF intends to pursue to achieve those goals; the Federal government uses the Strategic Plan to define key element for performance management. The NSF will be assessed in terms of progress toward its goals. Dr. Meacham noted the importance of the strategic goals clearly reflecting important, significant impacts for the country, its taxpayers, and other stakeholders. He noted that the first two strategic goals correspond to NSF’s merit review criteria of Intellectual Merit and Broader Impacts. The management objectives address internal processes to achieve organizational excellence.

Discussion. Dr. Hornberger noted that the Strategic Plan is a large undertaking, developed by a small group. Dr. Meacham agreed that it is a large undertaking, which requires a great deal of input. He noted that the planning group had held one round of outreach to the community and industry, and had received significant input through the website. A town hall meeting for NSF staff was held, the input of ACs is now being sought. Later in the process, the group will seek to synchronize the plan with Congressional priorities; OMB will provide comments on the draft. Dr. Meacham noted that the key stakeholders are the National Science Board and NSF Senior Divisions; the NSF ADs, as a group, have been tasked to serve as primary authors, receiving the input and shaping the final plan.

Dr. Prather asked Dr. Meacham how much change he expected from the current plan. Dr. Meacham replied that input on this question is being sought; particularly, whether the goals are right as defined. Given that the goals have stood up well for decades, Dr. Meacham noted that he did not anticipate much change in their scope, although the language might change, particularly if they are seen as not speaking well to young scientists or NSF staff in their current form.

Dr. Meacham also noted that the plan includes a narrative to accompany the goals and objectives. Input is requested on this language. Dr. Meacham noted that the discussion addresses the importance of education and diversity, and the need to prepare students for the full diversity of careers. He noted that the narratives are important for setting the overall tone and clearly establishing the values of the NSF.

Dr. Semeter noted that the NSF had published a 2011-16 Strategic Plan, but had then cut that timeline in half, releasing a 2014-16 Strategic Plan; he asked why this was done. Dr. Meacham replied that Congress had passed legislation that influenced the process, including the Government Performance and Results Act of 1993 and the Government Performance Act of 2010. He noted that Congress had been working in concert with the Administration since the 1990’s, to formalize the use of Strategic Planning. The 2010 legislation set a new clock, and required the issuance of a new plan with each presidential term.

Dr. Meacham also remarked that the older plans each emphasized different aspects of the NSF’s work; he noted, for example, an emphasis on cyberinfrastructure some years prior.

Dr. Hornberger remarked on the inclusion of defense in the NSF mission, and asked how that influenced the current plan. Dr. Meacham referred to the strategic goals and objectives, particularly the requirement that researchers describe the broader impacts of their work. When NSF reports to OMB and Congress, they look at what has flowed from NSF awards, making the connections between the basic research that is the focus of the NSF, and some of its implications for national defense. As an example, Dr. Meacham cited social science research on how teams work, which is used by the military to make units more effective. Dr. Meacham noted that one of the outputs of the Strategic Plan is making clear the benefits of the basic research NSF supports.

Dr. Falkner noted that the U.S. Antarctic Program is governed by a treaty that was seen to be the first arms control treating. She suggested science diplomacy, as exemplified by this treaty, which has secured the peace in the Antarctic for 50 years, as another contribution to national defense.

**Division Subcommittee Reports**

Prior to the Division Subcommittee Reports, Dr. Hornberger reported that staff had been called away in the morning for an internal NSF awards ceremony; he reported on awards to GEO staff and joined AC GEO members in offering congratulations to those cited. Dr. Wakimoto stated that he would convey the congratulations to staff not present at the meeting.

* **Atmospheric & Geospace Sciences** *Vicki Arroyo, AC GEO; Paul Shepson, Division Director, Atmospheric & Geospace Sciences*

Dr. Shepson reported that the Atmospheric and Geospace Sciences Division had had a good meeting with the subcommittee; he described the discussion as being “quite lively.” The Division and Subcommittee met via teleconference on Monday night, and reconvened this morning; Dr. Shepson noted his remarks would focus on the call more than that morning’s discussion. Topics addressed included 2-way communication with the community, program agility and responsiveness, and Broader Impacts.

Regarding two-way communications, the subcommittee expressed concern and the desire to do better in assuring that the community understands their operations and priorities, particularly in regard to Broader Impacts. A Science Assistant has been hired to focus on improving communications through a new web page, Twitter, and other strategies; the goal is greater community interaction through the program portal.

The discussion of program agility and responsiveness focused on interdisciplinary proposals. Dr. Shepson noted that it is difficult to measure the division’s success in receiving and handling proposals that do not fit directly into a program. Measures that might be used to assess this success were discussed; the fraction of awards that are cofounded, for example, was found to be an ineffective measure. The discussion also addressed how to quantify other efforts, such as program director interaction with other directorates, encouraging collaboration, or making deals for proposal support. Data on these efforts are not available; Dr. Shepson remarked that he believed the division was doing well in these areas, nevertheless.

Dr. Shepson remarked on a lively discussion on Broader Impacts, including different categories of Broader Impacts, and success and challenges in communicating to the community the importance of addressing this criterion. The discussion also touched on highlighting PI achievement, and whether the division has staff who can effectively communicate PI success.

Other topics in this discussion included communicating the importance of Broader Impacts to PIs, and the suggestion of having a conversation with PIs whose approach to Broader Impacts in their proposals appears to be simply “lip service.” Dr. Shepson reported that he believed these efforts to be proceeding well.

Community broader impacts, cases in which multiple PIs and communities work to develop clear Broader Impacts, such as the predictability of weather forecasting, was also discussed. Dr. Shepson noted that a National Academy report included a chapter on the history of community science and its impact on the national welfare. He noted that tens of thousands of lives are saved every year because of the achievements in Atmospheric and Geospace Sciences on air quality. Ozone depletion and recovery offers another example, stemming from the achievement of a single PI, and culminating in the Montreal Protocol 14 years later. Dr. Shepson reported that 2 million cancer deaths per year will be averted by 2030, due to this work. Finally, he noted that the problem of acid rain, and the acidification of eastern lakes, was solved by PIs funded by the NSF and other agencies.

Dr. Shepson noted that NOAA takes credit for weather forecasting, although the fundamentals of this science developed from Physical and Dynamic Meteorology and other NSF communities.

Dr. Shepson reported that the subcommittee also discussed climate change, an area in which he described the community as being “passionately interested and profoundly proud of the work that has been and is being done,” such as quantifying climate change and climate impacts such as storm surge. He noted that many people in the community feel that NSF is downplaying their contribution. He shared concerned that, if it makes sense to downplay the contributions to climate change this year, will it also make sense to do so next year, and the next, and ten years from now. He noted deep concern that NSF might be putting itself at risk of being on the record as perceiving climate change to be relatively unimportant.

Dr. Arroyo remarked that some members of the subcommittee were surprised at the lack of a formal requirement for PIs to report out and assure NSF credit; she noted that some reported difficulty in having NSF represented at press conference in which their NSF-supported successes were publicly lauded. She suggested that a freelance science writer might be hired to “connect the dots” more clearly, between NSF support, scientific discovery, and community impacts.

Dr. Arroyo also remarked on the concerns Dr. Shepson shared, regarding the absence of climate change within the 10 Big Ideas; she noted as well the need to translate scientific findings to engineering and planning fields. She remarked on a meeting she had the previous week, with the Head of Louisiana’s DPQ, who is working on revising the State’s coastal masterplan, and finding that prior “worst case scenarios” are now “best case scenarios.”

Dr. Arroyo remarked on the importance of the work being done in geosciences, and the need to make the impacts measurable. She noted that it is difficult to discuss climate change when you’re unwilling to call it climate change, and asked at what point that term might be used, so that the NSF does not conspire to downplay it. She remarked that AC GEO members seek to inform these discussions, and appreciate the willingness NSF has shown, to accept and implement AC advice, particularly internally.

Dr. Arroyo reported that the 10 Big Ideas caused her to wonder if there were more effective ways to use the time and effort of AC members, to assure that the impact of the great work being done within NSF is being shared. She noted that industry is already incorporating geoscience predictions on climate change, and asked how NSF might serve as a leader on climate change, as the Department of Defense is on climate resilience and the National Institutes of Health on cancer.

Dr. Arroyo acknowledged the challenge of addressing climate change in the current political environment, but shared her concern that NSF has pulled back too much. Dr. Semeter agreed, noting the centrality of questions regarding the habitability of the planet and resilience of our species. He acknowledged that others might think these questions too broad, and suggested that the New Arctic big idea might serve as a practical means of imposing climate research into the big ideas.

Dr. Hornberger recalled statements from the previous day, that NSF could not possibly “own” the topic of climate science; he noted that NSF could still highlight it, in terms of the big ideas.

Dr. Prather noted the remark that NIH made itself important by saying they would solve cancer; she remarked that “cancer won’t matter if we aren’t on the planet.” Dr. Prather shared her concern that NSF was “playing into the hands” of those who would ignore climate change; she remarked that “the more we keeping backing up, the more we will be pushed,” and asked “at what point do we push back?”

Dr. Wakimoto noted that the NSF has put forward INFUSE, Risk and Resilience, and now, the New Arctic; all three initiatives have climate deeply imbedded within them.

* **Ocean Sciences** *Rana Fine, AC GEO; Richard Murray, Division Director, OCE*

Dr. Fine began by noting her strong agreement with the statements made in the AGS report; she noted her perspective that the “10 Big Ideas fall flat.”

Regarding Ocean Sciences, Dr. Fine reported that the subcommittee spent much of their time discussing the budget. She noted that the Division had had a large challenge presented them, through the Sea Change report. The subcommittee is very supportive of the work being done to rebalance the budget in terms of infrastructure and research. Dr. Fine reported that the Division has made “huge progress in implementing the Sea Change report,” and that there is more to be done; the subcommittee looks forward to further progress.

Dr. Fine noted the need to consistently review infrastructure and the related science during the rebalancing process, assuring that shifts are made in light of what makes the most sense for science. She reported that OOI, moorings, ships and the drilling program had received the largest cuts as a result of the rebalancing. She also noted that many proposals contain infrastructure, offering as an example the deployment of Argo sensors. Dr. Fine reported that a review of these sensors is planned.

The Division will also review ocean models; Dr. Fine remarked that models typically began with physics, then moved to chemistry and biology. Modeling has progressed to the point that these disciplines must be integrated; she noted that ICER bridge money has been helpful in advancing this progress, and asked Dr. Wakimoto if he could share any insight into future ICER investments.

Dr. Wakimoto replied that leadership felt it important to provide Ocean Sciences a “soft landing” through the provision of additional funds. Future ideas under consideration include mid-scale infrastructure; he noted that every division could name a desperately needed mid-scale project.

Dr. Fine remarked that Ocean Sciences will need to attend to data management and infrastructure, which will affect much of the Division’s work, from individual PIs to infrastructure and instrumentation. She noted the need for more time and capital to be focused on these concerned.

Dr. Murray thanked subcommittee members for their active engagement with Division staff, noting that the questions raised were important to the Division; he also offered thanks to Ocean Sciences staff who participated.

PLR and OCE joint meeting. Dr. Doney reported that the Polar and Ocean Sciences Divisions held a joint meeting to address harassment on ships at sea. He noted that the topic concerns both safety and diversity issues. Dr. Doney noted that the problem was made more complex because of the variety of personnel on board: scientific parties, ship crews, and science contractors, as well as the home institutions of American and international scientists. A partnership between NSF, ship operators, other federal agencies and institutions is needed to address harassment.

Dr. Doney reported that some progress has been made; harassment training has been offered on some UNAL ships, and there is some movement to make such training mandatory. A UNAL ad hoc committee has been convened to work at pregnancy, privacy and harassment, and to develop policies around these issues. The suggestion has been made that UNAL’s early career chief scientist program should include training on addressing harassment.

The Divisions discussed raising awareness, developing training, and addressing strategy to improve the lines of reporting. Dr. Doney noted that the command structure environment on ships has not been sufficient; lines of external reporting to persons onshore are being considered, and have been utilized in some Antarctic programs. Other discussions included efforts to incorporate policy changes in UNALS cooperative agreements and NSF inspections of the fleet. An AGU workshop on harassment was supported by NSF in September 2016; other professional societies have expressed interest in promoting these policies and concerns.

Dr. Doney noted that issues of harassment extend beyond ships, to remote field camps and other locations; he suggested that ships provide a good location to begin these efforts. He recognized the need to address issues on campus, but noted the unique challenges in geosciences, because of the field work involved.

Dr. Doney noted that 45 minutes was insufficient to address the topic during this meeting; a teleconference has been planned to continue the discussion.

Discussion. Dr. Constable reiterated Dr. Doney’s remark that issues related to harassment extend beyond ships to field work in general. An AGU taskforce is considering modifications to the ethics statement to address harassments. Last fall at AGU, an open session on the general topic of harassment was held. Dr. Doney noted that social science research has identified effective strategies for addressing harassment; he noted that a lot of work has been done in anthropology, as they have addressed harassment in their field. Dr. Constable noted that members of the AGU task force were reviewing this evidence and history.

* **Polar Programs** *Berry Lyons, AC GEO; Kelly Falkner, Division Director, PLR*

Dr. Lyons thanked Dr. Doney for his summary of the joint meeting; Dr. Lyons underscored the importance of the issue for all field science, and encouraged all AC GEO members to get involved in thinking through strategies for addressing and reducing harassment.

Dr. Lyons reported that presentations were offered to the Polar Division subcommittee. The first was by Anna Kotula, Program Director for Arctic Social Science, on the results of the Arctic Horizons revisioning process. A year was spent organizing, planning, and holding six workshops to bring together members of the arctic social science community and indigenous communities to reassess goals, potentials, and needs of these communities in the context of rapid change.

The Arctic Social Science program has been in place since 1990; Dr. Kotula reviewed the program in a presentation that will be made available to AC GEO members. Dr. Lyons reported that at the last workshops, in 1998, only 29 percent of participants were women, and only 3 percent Alaska natives; this year, participation included 51 percent women and 30 percent Alaskan native and Native American people. Between 30 and 50 people attended each workshop; which address questions regarding how Arctic social science had changed, and what contributions is Arctic social science making to science in general. A Steering Committee is developing a draft document, which will go to the community for feedback before it is finalized in advance of the next proposal solicitation. A major paradigm shift is reflected in new solicitation language on indigenous scholarship; the newest solicitation says that the program has a special interest in a wide range of indigenous scholarship.

Dr. Lyons reported that everyone was impressed with this work bringing the community together and gathering feedback on what programs should be like and should emphasize in the future. He suggested this project could serve as a model for other programs.

Another presentation, by Eric Saltzman and Paul Cutler, reported on a joint NSF-Natural Environment Research Council (UK) solicitation, which was discussed at earlier AC GEO meetings, and was released today. The solicitation focuses on Thwaites Glacier, and its contribution to sea level rise. Dr. Cutler presented the science, including ongoing research on the Amundsen sea coast. The program is geared toward ocean, glacier, and atmospheric interaction; the drainage from the Thwaites Glacier is equivalent to 2 meters’ sea level rise. The solicitation addresses an important scientific program which was identified by the community. The solicitation is for a 5-year effort, to include two major field seasons. Joint American-British teams will be supported; proposals will be jointly reviewed.

* **Earth Sciences** *George Hornberger, AC GEO; Carol Frost, Division Director, Earth Sciences*

Dr. Hornberger reported that the Earth Sciences subcommittee discussed Broader Impacts at some length; there is strong interest in this criterion, and continuing concern that the community does not clearly understand the criterion. Dr. Hornberger referenced Dr. Patino’s earlier remarks about presentations to early career investigators; the subcommittee discussed the option of developing a white paper to discuss Broader Impacts more completely. Some uncertainties, such as the degree of innovation required, might be addressed in such a paper.

The subcommittee received a report on the RAPID awards; Dr. Hornberger noted the need to consider strategies to assure the ability to make these funds available when needed.

The subcommittee received an update on the EarthScope program, which is being recompeted. Dr. Hornberger noted that the interesting science questions “don’t stop at the coastline,” and he remarked on the challenges facing Ocean Sciences during the rebalancing process. He noted the need to continue discussions of ways to support research beneath the ocean.

Dr. Hornberger reported that the Division has received questions from the community about criteria listed for technicians in a recent call for funding for technicians in geochronology. The subcommittee offered suggestions for clarification, and supported the approach of separating funding for technicians; the subcommittee felt such dedicated funding was likely worth continuing and perhaps expanding to other subdisciplines in the future.

The subcommittee also discussed the upcoming COV, and developed feedback for Dr. Kempton, who will chair the COV.

Dr. Hornberger offered a comment about efforts within Earth Sciences to develop two-way communication with the community; he commended the rapid development of the microblog, noting that it allows rapid dissemination of information, and two-way communication. He remarked that it’s launch was a great accomplishment in just 6 months.

Dr. Frost offered her thanks to staff who made presentations, and to the committee and subcommittee members. She remarked that members were very good at providing advice with tact and grace; and that their advice was valuable in providing direction. She stated that she looked forward to providing updates on new items from the meeting.

Certificates of Appreciation. Dr. Wakimoto offered certificates of appreciation to AC GEO members whose terms end at the current meeting: Drs. Doney, Bierman, Arroyo and Hornberger. He thanked them for their input and advice during their terms.

**NSF Activities Related to Broadening Participation and Broader Impacts**

*Suzi Iacono, Office Director, Integrative Activities*

Dr. Iacono began the presentation on broadening participation and Broader Impacts by offering an overview of the merit review process at NSF. She noted that the NSF review is a multi-step process, which focuses on Intellectual Merit and Broader Impacts. Recent definitions of these criteria have included lists of activities related to training, teaching and underrepresented populations in describing Broader Impacts; these activities remain the most commonly thought of in this category. The America Competes Act of 2010 proposes eight criteria for Broader Impacts review; several align loosely with teaching, training, and increasing participation of underrepresented populations.

Dr. Iacono remarked that NSF has always received too many proposals with high technical merit to fund them all; additional criteria help to determine where to invest. The NSF has had up to 11 criteria; other federal agencies have several criteria, but NSF criteria have been condensed to two: Intellectual Merit and Broader Impacts. Since 1998, accountability has been instilled around Broader Impacts. Program Directors included a comment about Broader Impacts in their email signatures, asserting that proposals which do not address Broader Impacts will be returned without review.

Broader Impacts must be discussed and evaluated at each state, from proposal development through annual reports. COVs are also asked to assess Broader Impacts. Dr. Iacono noted that COVs tend to be very positive about the merit review process, but also note inconsistent language, lack of clarity, continued confusion, and a wide range of interpretations of Broader Impacts during the review process. COVs express concern about unnecessary randomness in the merit review process due to these factors, and several COVs suggest more extensive training for reviewers.

Approximately 1 year ago, an in-depth review of Broader Impacts was begun, with an eye toward data and deep thinking about how Broader Impacts are presented and the guidelines given to PIs and reviewers. Directorate-wide discussions were held with internal staff and ACs; a workshop for NSF leadership was held in September, and a report to OMB will be presented in December. An agency-wide strategic review is planned for the first quarter of 2017.

Three consensus hypotheses have been developed:

1. The application of Broader Impacts has changed over time; we should expect it to continue to evolve.
2. The so-called “confusion” is really variation in Broader Impacts due to different award sizes, disciplines, and solicitation language.
3. There are some common practices in panels, e.g., tie-breaking. Dr. Iacono explained that it appears reviewers look at Intellectual Merit, and then use Broader Impact to modulate their review.

Dr. Sullivan noted that none of the hypotheses allow for actual confusion among proposers and reviewers; Dr. Iacono replied that the hypotheses were stated in language that will help NSF determine how best to move forward.

Dr. Bierman noted that the COVs on which he had served had the impression that different panels held different expectations of Broader Impacts, depending upon the panel membership or program officer. Dr. Iacono invited Dr. Bierman to offer his own hypothesis; she asserted that the review had led to the hypothesis that this “inconsistency” is related to different award sizes, disciplines, and foci. She noted that Dr. Bierman could aid the agency in conducting another analysis, if he proposed a new hypothesis.

Dr. Bierman replied that he believed different PIs view Broader Impacts differently, not necessarily related to the size of the award. He agreed that different solicitations may shape the response, but asserted that responses are PI-dependent. Dr. Bierman noted that his approach to Broader Impacts changed as a result of a workshop he attended, and has changed as a result of his time on AC GEO. He asserted that there is “a very personal piece to this,” which might be addressed through training.

Dr. Iacono remarked that she heard Dr. Bierman propose a hypothesis based on experience; he agreed, noting that the timeline of experience might be shortened with training.

Dr. Sullivan remarked on the problem of a small *n*, in small research communities; he noted the possibility of different perspectives between small groups. Dr. Bierman remarked that he had seen panels swayed by a single champion for Broader Impacts.

Dr. Iacono resumed her presentation, noting that two questions were addressed in the strategic review:

1. How do directorates differ in their understanding of Broader Impacts?
2. To what extend do awardees report the Broader Impacts activities they propose?

A data analytic, machine learning analysis was used to review five types of NSF documents, related to NSF FY13 awards: project summaries, project descriptions, panel summaries, final project reports, and public outcomes reports. Dr. Iacono noted that not all the documents in these categories were machine readable. The review analyzed the Broader Impacts content of the machine-readable documents, and assigned each document to one of five Broader Impacts categories: advance discovery and understanding while promoting teaching, training, and learning; broaden participation of underrepresented groups; enhance infrastructure for research and education; broaden dissemination to enhance scientific and technological understanding; and benefits to society.

The analysis found clear differences across the directorates, and a strong focus on advancing discovery and teaching/learning in all the directorates. The Directorate for Social, Behavioral, and Economic Sciences (SBE) had the most even distribution across types of Broader Impacts; broadening participation was less common in GEO than in other directorates. The three largest directorates, GEO, Computer and Information Science and Engineering (CISE) and Engineering (ENG) have the greatest proportion of infrastructure Broader Impacts. In all directorates, Dr. Iacono noted, most of the Broader Impacts attention went to people, through training and teaching and broadening participation.

A subset of projects, for which both proposals and panel summaries were available, were further analyzed; Dr. Iacono reported that panel summaries appeared to attend more to broadening participation than did the PIs; this pattern will be watched, moving forward.

Dr. Bierman asked for further explanation of the categories reported; Dr. Iacono replied that word counts and word vectors are used to determine which categories are addressed in the documents; the analysis reports the single category that receives the highest word count. She noted that the analysis has not looked longitudinally at particular projects, to see what’s reported in the project description, the panel summary, the final report, for example. The ability to conduct these analyses is developing.

An analysis of the Broader Impact categories noted in proposals and in final reports was conducted, and these seem to be very close to one another. Dr. Iacono noted that the agency has been concerned about this aspect for some time; this initial analysis looks reassuring, but more analysis is needed.

The analysis found that there is not significant difference between the Broader Impacts noted in research and education proposals, although education proposals tend to emphasize broadening participation more than research proposals. Infrastructure proposals show less emphasis on teaching and training.

An analysis of differences across investment types by student groups found that education and research proposals tended to focus on graduate students, while infrastructure proposals focused on post-doctoral students. A look at the type of activity by student group showed that undergraduate students were primarily offered opportunities on research vessels.

The expected differences in Broader Impacts based on project size were not found; the breakdown was nearly identical for small, medium, and large awards. Dr. Iacono noted that the current analyses do not allow for identification of projects with more than one Broader Impact category; the current hypothesis is that larger award size proposals include larger discussions of Broader Impacts.

Dr. Iacono summarized the initial observations, not the presence of significant differences and some similarities across directorates. The distribution of Broader Impact categories in proposals differs from that in panel summaries, although the distribution in proposals and final project reports is similar. Some differences were found across investment types, but little different across award size.

An analysis of the representation of women among PIs and reviewers was also conducted, in light of a *Nature* study that found gender bias in earth science journals. This analysis found that women submit 27 percent of NSF GEO proposals, and are successful at close to the rate of men (21 percent versus 23 percent). One quarter of NSF GEO reviewers are women, and 26 percent of reviews are conducted by women. Between 2012-2015, female PIs submitted an average of 2.3 proposals, while male PIs submitted an average of 2.5.

Next steps regarding Broader Impacts include developing guidance for COVs, PIs, reviewers and NSF staff regarding Broader Impacts, including the expectation of heterogeneity across research communities and types of programs, and the expectations that Broader Impacts will evolve. Other efforts include continued analysis and additional presentations on Broader Impacts, to increase understanding of what Broader Impacts is and can be, and work with NABI on institutional and collective Broader Impacts.

Discussion. Dr. Bierman thanked Dr. Iacono for her presentation, and expressed his support for efforts to disseminate knowledge about Broader Impacts, perhaps through reporting requirements. Dr. Iacono agreed, noting the value of creating access and supporting replication and collaboration in efforts to develop curricula, train citizen-scientists, and other innovative approaches.

Dr. Sullivan noted that he had seen negative review comments regarding a Broader Impacts approach having been done before; he also noted proposals supported because a strong Broader Impact program was being replicated. Dr. Iacono replied that her presentation had not addressed hypotheses that did not reach consensus, and there had been discussion regarding whether the criteria for Broader Impacts should be novel/innovative or evidence-based. She stated that this discussion continues, and may require a policy change to implement its conclusion.

Dr. Hodges remarked that he had heard stories of PIs being negatively reviewed for building on prior Broader Impacts ideas; he suggested such a review would be inconsistent with the intent of the criterion, and supported revising the language of the criterion to make this clearer.

Dr. Hodges also remarked on the possibility of panelists focusing on one Broader Impacts category as being most important. This, too, would be inconsistent with the intent of the criterion. Dr. Hodges suggested program directors might speak to panels about not allowing their preferences for a particular approach influence their reviews.

Dr. Doney noted that early career scientists sometimes struggle to develop Broader Impacts that are integral to the science being done, rather than appearing to be add-on activities. He suggested these PIs might benefit from support to develop Broader Impacts activities that are a more natural fit with their research. Dr. Iacono replied that NABI is conducting outreach to early career investigators; PIs can receive mentoring on Broader Impacts through a model that has been replicated at 14 sites.

**Meeting Wrap-Up: Open Discussion and Action Items**

*George Hornberger & AC GEO Members*

Dr. Hornberger opened a discussion of action items, noting the opportunity to respond as a committee to the Strategic Plan, or to develop a letter to the Director on topics of concerns. He also invited discussion of agenda items for the next AC GEO meeting, and the need, if any, for ad hoc committees.

A more strategic role for AC GEO. Dr. Fine noted that much of the time in the current meeting was devoted to receiving information, which might be disseminated in other ways; she suggested that future AC GEO meeting might be designed to allow more time for strategic discussions, to use the group in a more strategic way. Dr. Hornberger agreed this might be beneficial; he noted that the AC GEO has periodically engaged at a more strategic level, and might adopt that intent more generally. Dr. Constable noted her agreement with the idea of using the AC more strategically; she noted her work on another committee, for which members are expected to complete reading in advance.

Harassment. Dr. Constable suggested that the topic of harassment might be addressed at the next meeting, noting that the issue extends across all GEO programs and is gaining attention in the professional societies. She suggested the AC might review available social science and advise the directorate.

Dr. Cavanaugh noted that the AGU meeting may be held prior to the AC GEO Spring 2017 meeting; speakers to the AC GEO might be invited from that gathering.

Dr. Wakimoto agreed with the suggestions to conduct information sharing in advance of the AC meeting; he noted that he had urged program directors to do so as much as possible. He suggested that it might be timely to refresh the GEO Strategic Plan, noting that it might be titled a “visioning document,” to avoid confusion with the NSF Strategic Plan. Dr. Wakimoto suggested such a discussion would be timely as a new Assistant Director comes on board, and shared his expectation that the new AD would welcome more strategic discussion by and with the AC.

Replicability. Dr. Constable noted her impression that there was significant “unfinished business” related to replicability, as addressed by Dr. Stodden; she suggested further consideration of these issues at the next meeting.

Maintaining PLR-GEO Communication. Dr. Doney noted that two ACs were convened before PLR moved into GEO; he suggested that mechanisms for continued communication be developed if the programs are separated in the future.

AC response to Strategic Plan/10 Big Ideas. Dr. Cavanaugh noted that, while the Strategic Plan is intended to be a broad document, there are opportunities to identify imperative and urgent issues within it; she noted the AC conversations about climate change and suggested that the “backend” of the Strategic Plan might address it more directly.

Dr. Constable remarked on the limited time in which the AC might address the Strategic Plan; Dr. Doney noted that some committee are meeting via teleconference to develop their feedback. Dr. Hornberger remarked that AC GEO members would have to review the available materials in advance, if a teleconference was to be effective.

Dr. Dixon noted the tension among AC members regarding the 10 Big Ideas, and suggested there might be some way to diplomatically express these concerns. He suggested a teleconference, after members had time to learn more and consider their responses.

Subcommittee on Best Practices in Broader Impacts. Dr. Fuentes asked if a subcommittee might be convened to explore best practices for Broader Impacts in GEO, or in a particular program. He suggested that identifying best practices might advance the scaling of successful efforts. Dr. Hornberger remarked that the NSF was undertaking efforts in this direction, and that a smaller group that could maintain a more active interface with NSF might be helpful. Dr. Hornberger asked for volunteers: Drs. Fuentes and Lyons volunteered; Dr. Hornberger suggested Dr. Voorhees would also like to be involved.

Dr. Hornberger asked Ms. Lane to identify an NSF contact for the subcommittee; he suggested someone in Dr. Jones’ office might be appropriate.

Dr. Lyons remarked that he had not previously heard of NABI, and volunteered to contact the group; Dr. Wakimoto remarked that the NABI Director would be asked to speak to AC GEO.

Concluding remarks. Dr. Hornberger offered his thanks to Dr. Wakimoto for his service to the NSF; he noted the pleasure it had been to work together.

Dr. Wakimoto thanked Dr. Hornberger, and announced that Dr. Hodges would serve as the next AC GEO Chair. He thanked all AC GEO members for their support and assistance to him in his work.

**Meeting Adjourned**