Advisory Committee for Geosciences (AC/GEO)
October 17-18, 2018
Meeting Minutes

AC/GEO Attendees:
Kip Hodges (Chair)
Catherine Constable
Colette L. Heald
Pamela Kempton
Amanda Lynch
Chris Paola
Lina Patino
Stephen C. Riser
Joshua Semeter
Lisa D. White

Joining by Teleconference:
Gregory Hakim
Kaatje Kraft

NSF Senior Staff:
Scott Borg
Bill Easterling
Kelly Falkner
Anjuli S. Bamzai
Terrence M. Quinn
Melissa Lane

Wednesday, October 17, 2018

Welcome & Introductory Remarks
Dr. Hodges welcomed everyone to the meeting and asked those attending to introduce themselves.

Discussion of Draft Report, *21st Century Geosciences*
Dr. Hodges briefly described the history of *Dynamic Earth: GEO Imperatives & Frontiers 2015-2020* (DE) and discussed the Advisory Committee's (AC) work to date to create a DE addendum, including seeking community input at geosciences meetings. They found: 1) many people in the community had not heard of DE and were not swayed by its arguments; 2) no strong input from a wide variety of geoscience communities. This led the committee to rethink the addendum to include three components:

I. A general argument for the importance of the geosciences.
II. How GEO can best support and encourage the geosciences for the remainder of the century.
III. Specific findings and recommendations to GEO.

Dr. Hodges provided a few basic observations:

- Earth is increasingly understood as the quintessential example of a complex dynamical system, the evolution of which is driven by biological, chemical and physical process interactions that include influences from elsewhere in the solar system. These interactions lead to the emergence of phenomena that are compelling targets for geoscience research, including the emergence of life, the atmosphere, the oceans, and humans as a factor in geologic change.
- Planetary evolution is defined by a complex series of interconnected processes operating at timescales over 17 orders of magnitude, from billions of years to seconds. Technological innovations over the last two decades provide opportunities to study Earth system processes operating at varieties of scale ranging from an astronomical unit to a nanometer, or 21 orders of magnitude.
- The rise of humans as agents of geologic change has affected the nature of system research, establishing new imperatives to understand the coevolution of the planet and the societies that live on it. Increasingly, the most productive Earth science research transcends formal disciplinary boundaries within the geosciences.

Dr. Hodges asked the committee to imagine a nation with a new queen who plans to make the geosciences a royal priority, with adequate financial support, and the creation of the Ministry of P2C2E (Process Too Complicated To Explain) to encourage creative and impactful research. The committee began thinking about the structure and functions of this ministry to support trans-disciplinary research by suggesting descriptive adjectives. Responses included:

- adaptive
- agile
- agile
- apolitical
- audacious
- balancing competing demands on resources
- benevolent
- clearly relevant
- coherent
- collaborative
- communicative
- community of learners
- continually creating tomorrow's news
- creative
- data driven
- diverse (2x)
- dynamic
- efficient
- enabling
- evidence based
- excellent (2x)
- exploratory

- flexible (2x)
- flexible—know when to stop doing something and start something new
- forward looking (2x)
- impactful
- inclusive (3x)
- innovative
- interdisciplinary more than disciplinary
- listens to the community and other stakeholders
- nimble
- non-dominant
- open and transparent
- parsimonious
- pro community engagement
- problem centered, not discipline centered
- progressive
- receptive
- reconfigurable
- responsive
- respectfully challenging
- rigorous
- risk friendly
- top quality
- transformative
- visionary

Dr. Hodges pointed out that many of the documents that come to the geosciences directorate stress the importance of core funding, which often means preserving investigator funding over transdisciplinary funding. He noted that none of the AC's responses supported core funding. The committee also said the ministry needs to be inclusive and diverse, qualities he said need to be codified in an organization's structure. Diversity includes being welcoming, respectful, and supportive of researchers across the spectrum of the science community, without advantaging one demographic over another. Regarding agility, there needs to be a balance with the structure needed for the organization to get its work done.

Discussion:
Dr. Kempton said the community response, though limited, included protection for core funding. She stressed a balance between protecting some disciplinary effort while also creating more opportunities for interdisciplinary activities. Dr. Hodges agreed but said to do something transdisciplinary, someone's ox has to be gored. If the pressure for proposals comes in dominantly for multidisciplinary work, the ministry needs to be adaptive enough to put more funds into multidisciplinary work, he said. Dr. Kempton agreed, noting that the real issue is balance between blue skies and investing strategically.

Dr. Easterling said NSF tries to create connections between deep disciplinary science and interdisciplinary programs and deciding where the funding is going to come from. NSF has done

a good job of this, though the balance has not always been perfect. Vigilance from AC/GEO helps maintain the balance.

Following this discussion, Dr. Hodges asked the committee to provide descriptive adjectives for the structure that would best promote diversity and inclusiveness. Responses included:

- aggressive communication of opportunities
- broad minded
- commitment (i.e., walk the walk)
- consistent message
- creative and flexible for making connections between Minority Serving Institutions (MSI) and non-MSIs.
- diverse and inclusive structure promotes diverse and inclusive outcomes
- embedded (structures and leadership)
- excellence
- fair
- harassment-free workplace
- inclusive and diverse staffing and leadership
- just
- leading in this endeavor
- mentoring
- motivated to move the needle
- non-political
- opportunity for upward and lateral mobility
- problem focused
- representative (2x)
- require representative decision-making bodies
- respect for different perspectives and experiences
- safe
- self-aware of implicit biases
- supportive (2x)
- sustained effort
- willful

For the next group exercise, Dr. Hodges asked committee members what structures they would put in place to increase the probability of excellence. Dr. Constable answered that the organization should define excellence, which will depend on what it is doing. In some circumstances, it might involve the need to engage broad portions of society and in others it might call for being narrow and deep. Those proposing research need to understand excellence and the review panels need to understand what is being looked for in terms of excellence.

Other members responded with:

- ability to see the big picture
- broaden concept of excellence
- data driven
- depends on how excellence is defined

- distributed and not centralized
- diversity and inclusion embedded in peer review
- embrace risk
- employees with strong leadership and management skills
- expert employees in their fields
- forward looking peer review systems
- neutralized to remove biases from people
- not overly hierarchical and team oriented
- prioritize early-career researchers. (The system is biased the other way, so a preference for early-career researchers will promote innovation.)
- rigor
- rigorous competition for funding
- set high standards
- top notch employees
- transparent
- transparent reward systems

For the final group exercise, Dr. Hodges asked committee members to focus on innovation and agility, so the organization can be responsive to new and innovative approaches. Members responded with:

- address existential threats to humanity
- adequate staffing for responsiveness
- agile resource allocation
- balance excellence and risk
- broad solicitation of input
- do not penalize risk takers or support/encourage risk within measure
- employees that have buy-in of the vision of leadership
- greater instrument accessibility
- high risk and accept failure
- identifying innovation
- leadership that enables innovation by not being overly prescriptive
- Needs mechanisms for financial flexibility; don't tie up funding long term on infrastructure
- promote rotation of staff
- reserve some budget for small grants for crazy new ideas
- spread the seed broadly
- team structures
- wholistic evaluations

Update on NSF GEO Activities

Dr. Easterling announced the recent death of Michael Thompson, Acting Director of the Center for Atmospheric Research (NCAR) and asked for a moment of silence.

Dr. Easterling described some of the new science NSF is developing, starting with a Princeton Univ. team that used autonomous robotic floats for winter observations of the Southern Ocean, finding significantly more carbon dioxide is released in winter than previously believed. Also, University of California at Davis researchers used field observation combined with global bedrock weathering models to find that 26 percent of global nitrogen comes from bedrock.

After providing a high-level overview of NSF milestones, Dr. Easterling reviewed NSF's new sexual harassment policy:

- What we're doing: require awardee organizations to report findings of sexual harassment. Posted in the Federal Register last month—in effect Oct. 21, 2018.
- Why: NSF is committed to promoting safe, productive research and education environments for current and future scientists and engineers.
- NSF will not tolerate harassment, including sexual or sexual assault within the agency, at awardee organizations, field sites, or anywhere NSF-funded science and education is conducted.
- Upon implementation, the new term and condition will require awardee organizations to notify NSF of any findings/determinations of sexual harassment, other forms of harassment, or sexual assault regarding an NSF funded PI or co-PI.

Next, Dr. Easterling discussed NSF's gradual shift from a stronghold of fundamental curiosity-driven research to a blend of basic and applied science, emphasizing the recent emergence of convergence science signals NSF's total commitment to "use-inspired" basic research. Recent Atlantic hurricanes are an example. NSF is funding studies on the interaction of hurricanes and the built environment, on communications and decisions regarding evacuations, and is using Rapid Response Research (RAPID) for hurricane and other natural disaster research. But the real story on convergence is in NSF's 10 Big Ideas. Focusing on Navigating the New Arctic (NNA), one of the 10, he noted the Maersk container ship had successfully completed a trial run through the Northern Sea route; Russia's Novatek is using a short Arctic route for LNG shipment; polar bears have appeared at the summit station; and there have been record-breaking temperatures. He reviewed Arctic research challenges and identified areas for potential surprises. Reviewing NNA activity by year:

FY 2018

- A Dear Colleague Letter (DCL) was issued (NSF 18-048).
- Coordination with Convergence, Harnessing the Data Revolution.
- Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) (Year of Polar Predictions).

FY 2019

- Request is $30 million. Working Group developing solicitation to support:
    - Robust, integrated pan-Arctic observational network.
    - Integrated modeling natural and human activities.
    - Partnering with governments, indigenous peoples and international organizations.

Funding is expected to continue at $30 million/year for another 4 years and possibly beyond. Dr. Easterling also provided a FY 2019 budget update:

- NSF and some other Federal agencies are under a Continuing Resolution (CR) that extends current funding levels for those agencies through December 7.

- NSF FY 2019 Request is $ 7.47 billion. Includes construction funding for Antarctic Infrastructure Modernization for Science (AIMS).
- House Committee on Appropriations report for FY 2019 budget expresses support for AIMS and includes recommendation for $127.09 million for the construction of three Regional Class Research Vessels (RCRVs).

The FY 2019 request includes a slight decrease in funding to most directorates to pay for the Big Ideas. GEO shows a slight increase; Ocean Sciences (OCE) gave up some funds in 2017 and those funds were returned in 2018, which shows as an increase. AIMS funding is resulting in a 14.3 percent increase to the Office of Polar Programs (OPP). The Integrative and Collaborative Education and Research (ICER) fund shows a 37.4 percent increase, reflecting funding that can be spent by other directorates participating in the Big Ideas. Planning is underway for the FY 2020 budget.

GEO staff updates include: a new OCE Division Director, Terry Quinn; Acting Atmospheric and Geospace Sciences (AGS) Division Director (DD), Anjuli Bamzai; DD searches; and GEO front office reorganization. Dr. Borg provided a brief overview of the reorganization. Designed to improve efficiency and modeled on changes other directorates have made, it includes restructuring the Office of the Assistant Director to change reporting relationships by creating sub-groups.

Dr. Easterling discussed NSF-funded research showing future hurricanes could drop significantly more rain and U.S. coastal research challenges. There is not a predictive capability for numerous geohazards common to coastal environments; a new initiative will address the risks associated with people moving to coastal areas.

Turning to major facilities and infrastructure, Dr. Easterling provided a list of those managed by the geosciences for the Polar Programs and discussed NSF's stewardship responsibilities.

He also said that a cooperative agreement with the University Corporation for Atmospheric Research (UCAR) to continue management of NCAR became effective on Oct. 1, 2018. NSF is providing funding to renovate the NCAR aviation facility, conduct maintenance at Mesa Laboratory and start a new early career visitors' program.

Updating the GEO/OPP Major Research Equipment and Facilities Construction (MREFC) status, he said keel laying for the Regional Class Research Vessel-1 (RCRV-1) is set for Nov. 2018 and the three RCRVs are to be delivered in 2021, 2022, and 2023. Final AIMS design review is to be completed this fall and NSB approval to start construction is expected in Feb. 2019.

He mentioned contract awards for the Seismological Facility for the Advancement of Geoscience (SAGE) and the Geodetic Facility for the Advancement of Geoscience (GAGE).

Internationally, NSF supports collaborations in inter- and transdisciplinary research and he cited the example of the Belmont Forum, where NSF is a major contributor to research into global environmental change.

Discussion

Dr. Constable asked if the sexual harassment policy is in response to long-standing issues and if reporting of incidents has become more timely. Dr. Falkner mentioned three individuals who worked to develop the new policy and said more work needs to be done. A harassment case in Antarctica spurred development of the policy and there were also cases in Astrophysics. Reporting has increased but a cultural change is needed. She referred to promising practices, preferring that phrase over "best practices," and said training not done well can exacerbate the problem.

In response to a question from Dr. Heald about the process upon notification, Dr. Falkner said it is important to not go afoul of privacy rules and not discourage universities from doing the right thing. A small group will have access to reports of harassment on a need-to-know basis. The Office of Diversity and Inclusion (ODI) administers the process. Dr. Borg added that Title IX applies to employing institutions, which limits NSF's authority. The American Geophysical Union (AGU) has folded sexual harassment into scientific misconduct, but Federal law requires NSF keep them apart. Reporting is through the grants program and if a university determines someone should not be on campus because of an ongoing investigation, NSF needs to know because it affects the university's ability to serve as the grantee institution. There will have to be greater awareness of the roles different organizations have.

Presentation on Proposed New Area of Interest on Coastlines and People (CoPe)

Dr. Amanda S. Adams, AGS Program Director (PD), discussed activities of the CoPe Working Group, which has participants from GEO, the Directorate for Biological Sciences (BIO), Social, Behavioral and Economic Sciences (SBE), the Engineering Directorate (ENG), Education and Human Resources (EHR), and the Office of Integrative Activities (OIA), and is an avenue for convergence research.

Workshops organized by UCAR were held in September in three cities and virtually with about 450 participants from a diversity of disciplines, career stage, sector and gender. Community recommendations were made in three categories:

- What are the interdisciplinary fundamental research topics around CoPe that the scientific community should tackle in the next 5-10 years?
- How do we integrate broadening participation into CoPe from the very beginning?
- What are characteristics of the structure a "hub" would need to support both science and broadening participation?

Recommendations, presentations, and white papers from the workshops are available online: (coastlinesandpeople.org). Dr. Adams listed the outcomes:

- Created a space for cross-discipline interaction on CoPe
- Emergent themes
    - Prediction, Preparation, Response and Recovery
    - Integration across temporal and spatial scales
- Broadening Participation

Dr. Adams said the next steps were to Synthesize the products of the workshops and feedback from the community.

Discussion

Dr. Hodges asked how the initiatives deserving support will be prioritized. Dr. Adams said the focus is on doing something that is needed, unique, and does not receive funding. Her group is also seeking a balance between ideas cited most often and those that are most novel.

Responding to a question from Dr. Kempton about engaging decisionmakers responsible for putting ideas into practice, Dr. Adams said 10-15 percent were either from other government agencies, non-profits, the private sector, or local government. Dr. Lynch said decisionmaker involvement was context sensitive and a responsibility of the researchers rather than the workshop process.

Dr. Riser asked how many participants are already working in the area. Dr. Adams said the group that applied for the workshops was diverse, though skewed toward those early in their careers, who were not as established into doing things a certain way. It has not been determined how many were new to the field, though some likely were, she said.

Dr. Riser asked about the dichotomy between applied and basic research and whether the funding will be new or come from another area. Dr. Easterling responded that the foundation recognizes there is a need for some new money, given the anticipated scale. But other initiatives have finite lifetimes, after which funding will be available for CoPe.

Dr. White asked what was behind participant support for broadening participation. Dr. Adams said reasons included workshop design, the diversity of participants, and participants not knowing each other.

Dr. Hodges said the two-week deadline for applying to the workshops almost guaranteed people were already interested in the problem and asked how it could be made inclusive of the broad community. Dr. Adams said a broad number of disciplines were represented. They may have already been thinking of coastal issues, but these participants know the emerging issues that need more work. The challenge is how to write a solicitation to be sure to get new ideas. The community also has a role in making proposals. Dr. Wade, who is on the working group, described efforts to disseminate the workshop announcement.

Dr. Easterling said he and others made efforts to talk to the community about soliciting inputs for CoPe. Also, some attendees were there out of curiosity vs. those seeking research funding. Dr. Adams mentioned that those not in attendance could provide input. Dr. Hodges urged broadening the call for input. Dr. Adams said the different directorates were involved in disseminating notice of the workshops. Dr. Easterling said other parts of the government have strong interests in the topic, providing opportunities to leverage NSF funding with other agencies. Dr. Kempton added that there are also possible funders outside the U.S. Dr. Hodges advised against writing the solicitation narrowly. Dr. Lynch advocated a mix of small and large projects. Dr. Constable said writing a proposal requires more than 30 days. Dr. Adams said the aim is to provide more than 90 days, but Dr. Constable noted the announcement is not seen as soon as it is announced. Dr. Easterling said this year is primarily for planning with a possible solicitation early in the new fiscal year.

Dr. Kempton said reviewers need to be educated to see that what is not necessarily innovative for a single discipline might be so when it is approached as an interdisciplinary project. Dr. Hodges agreed and suggested one-page proposals rather than full-bore proposals for a first pass to determine which ideas are likely to be competitive. Those chosen in this first phase would have more time to complete a full proposal for the next phase. Responding to Dr. Easterling, Dr. Adams talked briefly about the working group's diverse composition.

Discussion of Convergent Science (Continued)
Dr. Hodges used the remaining time to again discuss convergence, asking Dr. Easterling for clarification on the relationship with use-inspired science. Dr. Easterling said it would be a mistake to construe convergence as only use-inspired science. As examples, he mentioned improving the predictability of tsunamis and a Manhattan Project to improve 14-day weather forecasts. Dr. Hodges said another example is how the chemistry of the ocean evolved, which is not easy to answer in the context of an individual program. Dr. Easterling agreed, saying it would need to be framed as a tractable problem worth support under a convergence framework.

Working Lunch: Discussion of Draft Report, *21st Century Geosciences* (continued)
Addendum. Before beginning the scheduled topic, Dr. Easterling supplemented his morning presentation. The new infrastructure awards approved by the NSB includes the Ocean Observatories Initiative (OOI). OOI has moved to the 2.0 phase and a cooperative agreement reached with Woods Hole Oceanographic Institution (WHOI), which will have an initial 5-year award for $44 million for 5 years, with the possibility of a 5-year renewal.

Dr. Kempton raised the issue of excellence. With interdisciplinary initiatives, reviewers have to be educated on the meaning of excellence and the response. The issue is how to convey it to the community that is doing the reviewing. Dr. Hodges asked if the issue is handled better today than 10 years ago. Dr. Kempton couldn't answer but recommended spending up to half a day talking about excellence during the panel meeting. Widely differing evaluations can come from from a misunderstanding of excellence because people are judging based on their own discipline and feel unable to assess the whole proposal. Dr. Borg said this has long been recognized and is something Program Officers (PO) attend to; it is not rare for panels to talk about the issue. But no one has solved the problem for ad hoc reviewers, so there is resistance in internal discussion for going to virtual panels. It is also a challenge for the no-deadline situation. So, for special solicitations, the emphasis will be on in-person panels. Dr. Bamzai said that for large interdisciplinary or interagency competitions there are pre-panel Webinar briefings to discuss inherent bias, hoped-for outcomes, and solicitation-specific criteria. For CoPe, there should be pre-panel briefings. Education has to be done after the deadline for receiving proposals.

Dr. Lynch said the process has only marginally improved over the last 20 years due to no deadline and the challenge of assembling a panel. More people decline to participate. Also, the page limit is an issue, though increasing the limit is an imposition. She emphasized training the panel to not be swayed by disciplinary bias.

Dr. Easterling said NSF has been funding interdisciplinary big science for decades and developed a growing community of broad-gaged scientists willing to think beyond their own

disciplines. Dr. Lynch disagreed, saying there are creative ways of getting things funded through multiple paths at once. A survey she did on what the community thinks about future directions for Polar research included questions about funding for interdisciplinary work and the social sciences. About a third of respondents said NSF should not fund social science.

Dr. Constable said even within the core programs everyone is guilty at some level of seeing new or interdisciplinary things and not knowing how to evaluate it. It comes down to willingness on the part of NSF to take risks.

Dr. Kempton said the challenge is less with a program like CoPe, where aims and outcomes are defined, than with proposals that come from the bottom up to a disciplinary area, which doesn't have the reviewers to make that work. She suggested reviewing bottom-up interdisciplinary projects as an interdisciplinary initiative by a panel trained to look at that, rather than doing it alongside the disciplinary proposals. Dr. Hodges said Dr. Kempton's idea should be considered. Using solicitations alone for large, multidisciplinary projects is limiting to GEO and the community. There is a need for different structures for interdisciplinary proposals where you borrow reviewers from other panels and educate them, which would invite broader participation among people doing interdisciplinary research.

Dr. Borg said that is being done. The challenge is to empower POs to discard that aspect of the panel summary. At NSF the PO decides. But with the number of proposals, reviews are leaned on perhaps too much. Dr. Hodges said current mechanisms are not sufficient because many who write multidisciplinary proposals that bubble up from the bottom think there's no place for them to go. The issue to how to publicize the ability to get those proposals funded.

ACTION ITEM
The committee should consider making specific recommendations about publicizing how interdisciplinary proposals can receive appropriate consideration.

Dr. Hodges added that ad hoc reviewers can only compare the proposal with what they see during a regular programmatic proposal, which is incredibly dangerous for interdisciplinary proposals. He supported panels designed to work on interdisciplinary proposals. Dr. Quinn said this is a recognized problem that is being worked on, encouraging POs to select panels that think outside their disciplines. Dr. Hodges said POs are finding it harder to get a large number of reviews for a proposal, resulting in small sample statistics, with two unfair negative reviews skewing the outcome. Dr. Lynch people are motivated to get their review in if they feel strongly about it. When people are time poor, there will be a bi-modal distribution.

Dr. Hodges asked about a review with five excellent evaluations and one poor one. If the PD shows it to the panel and there is no one with expertise in that field, it is likely they will defer to the wisdom of that reviewer, though it may be aberrant. Dr. Quinn said it similar to an associate editor telling the principal investigator (PI) to ignore Reviewer 2 and focus on the other two reviewers' comments. Dr. Hodges said these discussions might lead to encouraging POs to be proactive and buck the panel.

Dr. Constable said requests for interdisciplinary proposals tend to be focused in specific areas, with NSF making a prescriptive description in the Request for Proposals (RFP) that requires interaction with a cyber infrastructure specialist, for example. It is almost as though there needs to be a core program for interdisciplinarity.

Dr. Riser said the number of Program Officers who only rank the panel results and draw a line is equal to the number who are more creative. Also, most panel reviewers also serve as ad hoc reviewers, so it is up to the PO to sort it out.

Dr. Kempton said the United Kingdom had: 1) an interdisciplinary program with no constraints on what could be submitted; 2) a bottom-up program for strategic ideas using short proposals, with those selected for further development open to all applicants. Dr. Heald, referencing the latter, said there's a challenge getting people to submit their best ideas when everyone can compete for funding to carry it out. Dr. Kempton said in that case researchers can choose the first option. Dr. Hodges suggested giving an advantage in the second program to those who originated the idea. Dr. Borg said the U.K. experience lead to the Thwaites Glacier partnership in OPP. A Natural Environment Research Council (NERC) exercise identified that as a priority area and a joint solicitation developed.

Dr. Borg referenced cases where panels without the appropriate expertise recommended the PO seek an additional review. Then the PO must decide whether to decline the proposal or take the time to seek additional reviews.

Dr. Falkner said the good practices mentioned to help panels see the bigger picture play out regularly in system science programs in OPP and that the community is rising to that challenge. Also, the Arctic portfolio is being examined to best attract the full breadth of what is needed to promote Arctic science. She cited Dr. Borg's thought that ideas for the Antarctic are being left on the cutting room floor because they did not have a home. Dr. Falkner referenced a GEO program no longer funded, Frontiers in Earth System Dynamics (FESD), which Dr. Constable called the ultimate interdisciplinary program, conceding she was one of those saying the proposers don't know what they are talking about in some cases. The problem is that it takes a year or two at least to create a collaboration across the fields involved. Dr. Falkner said FESD ran for 2 to 3 years and was stopped for budgetary reasons.

Dr. Paola asked about studies of how to foster interdisciplinary research and suggested gathering lessons from the oil industry. Dr. Falkner said interdisciplinary proposals had slightly better outcomes, according to a study initiated by the National Science Board (NSB), but these data are not recent. Re industry, she said the committee could invite a speaker.

Dr. Hodges said he expected interdisciplinary proposals to be more successful because they are usually in direct response to a solicitation but doubted the same success for bottom-up interdisciplinary research. There is a missing home for proposals that do not require a big research group that will take years to produce. Dr. Constable said interdisciplinary proposals can be very general, because of lack of space or because they are too ambitious and do not exactly describe the problems to be addressed.

Dr. Semeter suggested a program similar to RAPID for interdisciplinary collaborations, rather than for timely ideas that need quick turnaround. Investigators from different disciplines would receive small grants to write concept papers, leveraging the community for broad peer review through journal articles, which would give people confidence when they review the larger proposals that grows from those articles. Dr. Hodges supported the idea. Dr. Lynch said small grants worked well for project development because it is time consuming to develop teams that understand each other's language and jargon. Dr. Bamzai said Small Grant for Exploratory Research (SGER) was replaced by the Early Concept Grants for Exploratory Research (EAGERs), which funds proposals not expected to fare well in the peer review process because they are out of the box. Dr. Borg said SGER had five criteria for rapid response and off the wall ideas. That was split into EAGERs and RAPID. An EAGERs mechanism could be used to flesh out an idea. NSF would require the product to be widely read, avoiding making awards to write proposals. NSF funds ideas lab solicitations to bring people together to talk about ideas. It doesn't create a commitment for follow-on funding, but you have money to develop ideas. Dr. Falkner quoted the EAGER Web page: "The EAGER funding mechanism can be used to support exploratory work in its early stages on untested, but potentially transformative, research ideas or approaches. This work could be considered especially 'high risk-high payoff' in the sense that it, involves radically different approaches, applies new expertise, or engages novel disciplinary or interdisciplinary perspectives."

Dr. Paola suggested asked if Program Managers (PMs) perceive themselves like venture capitalists who are free to invest on their own instincts, which he said is a good model. He said some see themselves instead as vehicles for converting community input into funding decisions. Dr. Easterling said some very creative POs see risk as opportunity. Dr. Borg mentioned the unintended consequences of lower funding rates, disincentivizing POs to take risks. Some tie themselves too much to the will of the community. Dr. Paola said NSF leadership has a role in encouraging culture and it is the committee's responsibility to weigh in. Dr. Easterling said there is a balance between keeping the trains running on time and starting new things. CoPe started with a conversation that the leadership led, informed by *Dynamic Earth*. We realized if it is going to succeed it cannot be a top-down unfunded mandate, he said. NSF tries to take risks where it can and seize opportunities where possible. Dr. Falkner agreed with Dr. Easterling and took Dr. Paola's point that NSF leadership can reward behaviors, where permitted by law. There is enough understanding and appreciation of recognition by your peers for advancing the mission. People buy into this mission that we need to promote the progress of science and that is where we have our leverage right now, but it is good to be reminded of that responsibility. Dr. Hodges agreed with Dr. Paola that it is the responsibility of leadership to create the environment and culture and if that culture is important, there has to be some push from the top down into the level of the POs that this is the sort of behavior that would be rewarded.

Dr. Constable suggested thinking about risk-taking in a broader context. Thinking of PMs as venture capitalists, you also have to think of lost opportunities and putting money elsewhere. There are places where NSF is already taking risk. Every proposal that does not produce an interesting scientific product is where a risk was taken and did not pay off. It would be interesting to have a broader analysis of risk across multiple programs. Are those risks paying off or would they be better off putting those funds into more established senior scientists? She suggested having a discussion across all the programs about how people view that.

Update on Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES)

Dr. Sylvia James, Deputy Assistant Director (Acting) EHR and Dr. Don Millard, Acting Division Director and Deputy Division Director of the Engineering Education and Centers (EEC) Division, ENG, and co-lead of the INCLUDES design team. Dr. James described INCLUDES as a comprehensive national initiative designed to enhance U.S. leadership in discoveries and innovations by focusing on diversity, inclusion, and broadening participation in science, technology, engineering, and mathematics (STEM) at scale. Year 1 (FY 2016) accomplishments included:

- First cohort of 40 Design and Development Launch Pilots (DDLPs) (NSF 16-544)
- 13 Conferences/ Workshops (Dear Colleague Letter 16-081) supported
- 3-year evaluation contract for developmental evaluation with 2M/Mathematica
- 3-year technical assistance contract with EDC/Westat/Equal Measure

Year 2 (FY 2017) accomplishments included:

- Engineering Education and Centers (EEC)
- The Science of Learning
- Materials Research Science and Engineering Centers (MRSECs)

In January INCLUDES brought together 160 participants from EEC Centers, The Science of Learning Centers, MRSECs and elsewhere for a Center Summit about broadening participation. There followed a Principal Investigators (PI) meeting with 200 participants.

Seventy Design and Development Launch Pilots (DDLP) were awarded grants in FY2016 and FY2017 to address broadening participation challenges, such as expanding access to quality STEM education; addressing career needs of STEM professionals; preparing STEM educators; addressing students' STEM identity, attitudes, and motivation; strengthening institutional capacity; enhancing support systems for undergraduate and graduate STEM students; and providing engaging STEM activities for students and the community to promote STEM studies and careers.

INCLUDES has partnerships with 758 organizations working to broaden participation in STEM, including libraries, national labs and centers, government agencies and affiliates, schools, institutions of higher learning, private foundations, professional and higher education organizations, corporations and corporate affiliates, and non-profit and community organizations.

Dr. Millard said INCLUDES is high-risk because it is trying to move a needle that has been stuck. Engineering has been stuck at about 20 percent women. In Year 3 INCLUDES developed on-ramps to INCLUDES by providing supplements and workshops that connect to the INCLUDES framework and bringing in the centers to one meeting. A Coordination HUB (NSF 17-591) was awarded as a cooperative agreement and the first cohort of five alliances, or centers focusing on scaling best practices (BP) in broadening participation (NSF 18-529), including the Computing Alliance of Hispanic-Serving Institutions. The Hub will facilitate activities needed to build and maintain a strong NSF INCLUDES National Network, including communications,

technical assistance, and efforts aimed at increasing visibility. The Hub itself is a collaboration of multiple institutions.

Dr. Millard also discussed a memorandum of understanding (MOU) with Boeing, the first business to contribute to NSF INCLUDES nationally, which includes a $1 million gift to target women in STEM and women veterans returning to the workforce. A DCL will be released this fall.

In FY 2019, INCLUDES will build its national network with:

- NSF INCLUDES Alliances and Coordination Hub Kick-off (October 3, 2018)
- STEM Funders Collaborative Meeting (October 25-26, 2018)
- Convening the NSF INCLUDES National Network (January 2019)
- Second round of NSF INCLUDES Alliances (NSF 18-529, Deadline: April 2, 2019)
- Report to the Nation 2

Dr. Millard asked the committee for input on what the network might include. He and Dr. James said network benefits might include:

- Mechanisms to engage potential members, such as affinity groups
- Access to a repository for data, reports, and research on BP strategies and research
- A funders collaborative that provides access to local and regional funders
- Certification for members as NFS INCLUDES Leaders in Diversity and Broadening Participation; prizes/awards and recognition for BP work
- Opportunities for training and education and to replicate, adapt, and adopt evidence-based approaches to addressing BP challenges

For the FY 2019 INCLUDES budget:

- A total of $20 million may be available
- Co-funding will be encouraged from all directorates
- This will fund approximately three to four new alliances, 8-10 on-ramps, approximately 10 DDLP-like projects, convenings, and the mortgage on the Alliances and Coordination Hub.

Discussion

Dr. Paola asked about working with different cultures, such as Native Americans. Dr. James said there was a pilot project associated with tribal colleges, but the alliances are just being launched and it is up to the proposers to address. The Coordination Hub will address common metrics, what works, and how effective strategies can be expanded. Dr. Millard said INCLUDES is looking for alliances to help frame the studies. INCLUDES works with private colleges to better prepare students and address local constraints and hopes to scale the lessons learned.

Dr. Hodges said he is concerned with transitioning students in the STEM pipeline to working scientists and engineers and asked if the alliances can more directly link students to internships and research opportunities. Dr. Millard said one of the alliances recognizes the transition from community colleges and opportunities for industry internships by working with local industries. He hopes to see this expand to larger hubs as part of a large network. Dr. James anticipated a DCL for new onramps to alliances, which can add other partners and new ideas in the short term

and later possibly an alliance to focus on Hispanic students entering careers post-graduation. Dr. Hodges asked about putting onramps into disciplinary grants as part of the broader impacts component. Dr. James said it was a good idea that can be taken into consideration.

Dr. Easterling said the demand for geoscientists is higher than the ability to meet it, requiring broadening participation. GEO has a long history of trying to increase participation but has to do better than one-off experiments. INCLUDES is a big opportunity for GEO. He announced his intent to bring more funding to INCLUDES from GEO, either this year or next.

Discussion: Strategies for Stabilizing Graduate Student Support in the Geosciences
Dr. Brandon Jones, GEO/Office of the Assistant Director (OAD) Program Director, Education and Diversity, following up the previous discussion, referred the committee to Improving Undergraduate STEM Education: Pathways into Geoscience (IUSE: GEOPATHS), which includes a track focusing on institutional connections to support students in transition from a 2-year to a 4-year college or to graduate school.

Dr. Jones briefly described the Graduate Research Fellowship Program (GRFP), the National Science Foundation Research Traineeship (NRT) Program, Graduate Research Opportunities Worldwide (GROW), the Graduate Research Internship Program (GRIP), and Non-Academic Research Internships for Graduate Students (INTERN).

He also highlighted the *Graduate STEM Education for the 21st Century* report from the National Academies of Sciences (NAS); Inclusive Graduate Education Network (IGEN) and the INCLUDES-IGEN Alliance, which includes collaboration with The American Geophysical Union (AGU); the Geoscience Employer's Workshop; and an upcoming workshop at AGU for heads and chairs.

Dr. Jones asked if the current education model can adapt to what has changed in graduate education:

- Dramatic innovations in research technology
- Changes in the nature of work
- Shifts in demographics
- Growth in occupations needing STEM expertise

The NAS report concluded that graduate core competencies are:

- STEM Master's Degree
    - Disciplinary and Interdisciplinary Knowledge
    - Professional Competencies
    - Foundational and Transferrable Skills
    - Research
- STEM Doctoral Degree
    - Develop Scientific and Technological Literacy and Conduct Original Research
    - Develop Leadership, Communication, and Professional Competencies

Dr. Jones had the committee work in groups to formulate what they think the needed skills are for GEO grad student success in the workforce. The committee groups reported:

Group 1:

- Cultural adeptness
- Understanding languages and social norms
- Open-mindedness
- Self-correction, humility, and adaptability
- English-language skills for people coming to English-speaking countries
- Leadership, with skills in networking, mentoring, integrity, and research ethics
- Communication, including writing and speaking, contextual language, and audience awareness
- Technology, programing, and communication, social media, data analysis and visualizations, metadata quality control
- Project management
- Meta-cognition (thinking about the classroom vs. the real world; knowing what you know, what you need, and why you need it; and understanding your epistemological boundaries)
- Decision-making under uncertainty.

Group 2:

- Communication skills, verbal and written, including tailoring communication
- Presentation skills
- Quantitative skills
- Software skills
- Geographic information system (GIS) skills
- Teaching skills, including instructing others in one's employment area
- Teamwork skills
- Fieldwork skills (depending on context)

Group 3:

- Written and oral communication
- Systems thinking to embrace crossdisciplinarity thinking and the physical drivers of change
- Intellectual adaptability to support lifelong learning
- Algorithmic, analytical, and critical thinking skills
- Interpersonal skills, including self-awareness to accept criticism, awareness of the need for conflict resolution training, and awareness of biases

Committee of Visitors (COV) Report: Geospace/AGS Report

Dr. Robert McCoy, COV Chair, presented his committee's recommendations, with Dr. Michael J. Wiltberger, AGS Section Head, providing the NSF response. A rundown of COV membership was followed by the COV's charge and process:

- Followed the standard COV template
    - Quality and effectiveness of the merit review process
    - Selection of Reviewers
    - Management of Program
    - Questions about Portfolio

- Covered actions made in 2013-2017 period
    - For Aeronomy (AER), Magnetospheric Physics (MAG), Solar Terrestrial (STR) programs used a random sample of ~8 percent of jackets plus additional jackets identified by the program officers
    - For Facilities (FAC) and Space Weather Research (SWR) all actions except continuing grant increments (CGI) were examined
- Used two video conferences plus a 1.5-day in-person meeting to conduct the evaluation

The COV comments and findings were presented as:

- COV was highly impressed with the dedication of the GS staff
- Section is highly competent, professional, and motivated
- Commend the section program officers and staff for an effectively run program that serves the scientific community well
- Made significant progress in reducing mortgage balances and freeing funds for new initiatives

Dr. McCoy said the COV was very pleased and had no major concerns. He listed the recommendations and Dr. Wiltberger the responses, as:

- COV recommends that the section undertake options that would satisfy the intent of conflict of interest (COI) restrictions while enabling program officers to do their jobs effectively
    - NSF Response: Section will maintain its commitment to following COI guidelines while seeking waivers where appropriate
- While shifting to virtual panels has benefits the other two forms of review are still of value and should be used from time to time as necessary
    - NSF Response: While virtual panels are effective, we will use all review methods as appropriate
- Provide investigators with a redacted version of RA for their benefit
    - NSF Response: Will expand the use of PO comments to provide PIs with more information about decision
- Echoes previous COV and PR recommendation that GS collaborate with other NSF Directorates to enhance and strengthen the CubeSat program
    - NSF Response: Engaging with CISE/CNS and ENG/ECCS on the development of a new CubeSat solicitation
- The next COV should review the scientific impact of the CubeSat program
    - NSF Response: Prior to the next COV Space Weather program will evaluate the scientific impact of the CubeSat Program
- COV recommends NSF find ways to communicate information about BI to wider audiences at meetings and webinars
    - NSF Response: Included information about BI in agency presentations at the Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR) Program, The Geospace Environment Modeling (GEM) program, and Solar, Heliosphere and INterplanetary Environment (SHINE)
- Hold “town halls” at conferences to educate the community on the proposal and review process
    - NSF Response: Held town halls at CEDAR, GEM, and SHINE

- Recommends that NSF seriously consider providing additional funds to take advantage of the National Space Weather Strategy
    - NSF Response: Development of the NSF budget involves balance many different priorities
- Consider adding additional low-cost options, e.g. startup packages to the Faculty Development in Space Sciences (FDSS) program
    - NSF Response: Will consider these as we develop the new FDSS solicitation
- Gather information on rate at which mid-career scientists are being forced out of the field to supplement existing anecdotal information
    - NSF Response: AGS is hiring a Science Analyst and addressing this question will be part of their initial tasking
- Increase the length of the in-person COV meeting by 1 day
    - NSF Response: Will increase the length of the next in-person COV meeting
- Increase diversity by providing mentoring regarding proposal writing and reviewing, possibly through the use of office hours at CEDAR, GEM, and SHINE
    - NSF Response: Program officers held office hours at CEDAR and GEM

Discussion

In response to a question from Dr. Constable about FDSS funding, Dr. Wiltberger said there are $300,000 to $400,000 per year for FDSS and start-up costs vary. More information is being gathered on those costs and he will also collect information on how much it has helped to increase the number of graduate students in the field.

Dr. Hodges asked about improving launch opportunities for CubeSat. Dr. Wiltberger said NSF is engaged with the National Aeronautics and Space Administration (NASA) to launch CubeSats to do science that has not been possible before. Dr. Hodges suggested NASA's cooperation with private space launch companies presents opportunities for cost-effective launches. Dr. Wiltberger said his office is investigating private launching, mentioning the advantage of standardization and certain science challenges. Dr. McCoy added there are smaller launch companies gearing up to launch for even less cost that will enable NSF to launch its own rockets. Dr. Hodges said the companies would be willing partners. Dr. Wiltberger said cheap and repeated access to space can alter the engineering and science that researchers propose. Dr. McCoy said space has unleashed an explosion of ideas that can permeate NSF.

AC/GEO voted to accept the COV report.

Committee of Visitors (COV) Report: Integrative Programs Section (IPS)/OCE Report

Dr. Bauke Houtman, OCE Section Head, presented for the COV. He listed the programs reviewed as:

- Ship Operations
- Submersible Support
- Oceanographic Instrumentation
- Oceanographic Technical Services
- Shipboard Scientific Support Equipment
- Ship Acquisition and Upgrade
- Ocean Technology and Interdisciplinary Coordination

- International Ocean Discovery Program
- Ocean Observatories Initiative
- Education/Human Resources

He added that IPS executed 192 Actions during FY2014 – FY2017 and the COV reviewed 73 actions. Additional actions were added for activities that began prior to FY2014 but were active in the review period.

The COV's general comments were that:

- Program Managers excel in managing the diverse portfolio of programs
- Communication, professionalism, and transparency among Program Managers in the Section is impressive
- Proposal review process has improved in response to comments from the previous COV and appears very well managed
- IPS responded effectively to recommendations from *Sea Change* and program portfolio rebalance
- Excellent efforts towards a well-balanced portfolio with regard to institutional diversity, gender diversity, geographic distribution, etc.
- Excellent job managing available financial and human resources
- Remarkable job addressing institutional strategy and goals, managing budgetary challenges, and ensuring successful operations of facilities and programs fundamental to support the Ocean Science Community

The COV had these general findings and recommendations:

- COV Workload Management:
    - For transparency list all proposals in the ejacket interface for program context and only those selected are accessible
    - Download function interface should have a COI Stop Sign
    - Update COV website with option to view all documents on-line vice having some download automatically
    - IPS Program complexity requires more time for pre-COV material review
- Format of the COV template not user friendly for a Facilities Section
    - Develop a more flexible, IPS-centric assessment template
- Program will work with NSF IT and address items

Finally, Dr. Houtman presented the COV's specific recommendations:

- Ship Acquisition and Upgrade: 0 recommendations
- Ship Operations: 2 recommendations
    - A solicitation for Early Career Training to diversify backgrounds and expertise
    - An updated Ship Operations Program solicitation which includes consultation with operators to emphasize best practices in proposal preparation
        - Program will develop new solicitations

- Submersible Support: 4 recommendations
    - Assess and report to the community on operational efficiencies

    - Deep Submergence Science Committee to review planned Alvin 6500m upgrade
    - Highlight and leverage Deep Submergence capabilities with other agencies
    - Align Submersible Support Program priorities with DESCEND2 Report
        - Program agrees and will work with the University-National Oceanographic Laboratory System (UNOLS) and other agencies

- Oceanographic Instrumentation/Shipboard Scientific Support Equipment: 4 recommendations
- Increase the science focus in the review process
- Increase panel feedback on "Broader Impacts" evaluation criteria
- Increase the quality of the proposals
- Merge OI and SSSE into a single program
    - Program will work on the review process and with the community on panel evaluation inputs and improved proposal quality through training
    - New Scientific Instrumentation and Support Equipment (SISE) Program

- Ocean Technology and Interdisciplinary Coordination: 4 recommendations
    - Bring budget back to 2009 level
    - Pursue additional interagency collaboration
    - Pilot taking a project from development to full completion
    - Add instrument software/algorithm development to portfolio
        - Program continually evaluates budget and interagency collaborations
        - Program will identify a pilot project and consider a broader portfolio

- International Ocean Discovery Program: 4 recommendations
    - Retain IODP in IPS
    - Place a priority on mitigating the risk for drilling operations
    - Continue IODP education and outreach efforts
    - Continue efforts to support the seismic and IODP community science requirements
        - Drilling risk mitigated through awardee, Facility Board, Science and Safety Panels
        - Education and Outreach will continue through a separate award
        - NSF/OCE committed to providing access to seismic data collection capability

- Oceanographic Technical Services: 4 recommendations
    - Survey the Technician Pool participants to assess level of satisfaction
    - Provide 3-4 marine technicians on ships when needed
    - Continue to pursue means to increase bandwidth to ships at sea

    - Provide science party/crew guidance to minimize background internet demands on bandwidth
        - Tech Pool Survey showed relatively positive results

        - Program supports additional technicians and increased bandwidth within the availability of funding

- Ocean Observatories Initiative: 4 recommendations
    - Increase the use of metrics to track use of OOI data and nodes
    - Evaluate cost/benefit of redundancy deployments of critical elements
    - Include Global Ocean Observing System description on OOI website
    - Track and report impact of OOI ship time demand on non-OOI requirements
        - Program will work with OOI awardee and UNOLS to address each recommendation

- Education/Human Resources: 5 recommendations
    - Consider sharing longer term tracking data used by successful programs
    - Consider recommending REU sites include professional meetings attendance as part of proposal
    - Give high priority to a common application
    - If applicable, Advisory Committee consider issue of diversity beyond undergraduate
    - Continue process of summer intern assistance to gather/collate data
        - Program will work with community and within available funding to encourage data sharing, meeting attendance support and use of summer interns
        - Program understands full roll out of new application system will be in several years and REU Sites will be included

Dr. Houtman concluded that from the program perspective, it was a very valuable COV, and he looked forward to implementing the recommendations over the next several years.

Discussion
In response to a question from Dr. Kempton, Dr. Houtman said the recommendation under ocean technology to bring the budget back to the 2009 level does not, technically, run counter to changes made in response to *Sea Change* because ocean technology was not identified as a recommended area for reduction.

After Dr. Borg discussed the Advisory Committee's role in providing questions for the COV, Dr. Kempton asked if it would be possible to have on the agenda which COV is coming up next in order to discuss any questions. Dr. Hodges and other supported the proposal.

ACTION ITEM
Future AC-GEO agendas will include time to discuss upcoming COVs scheduled to report at future AC-GEO meetings.

Dr. Borg said AC-GEO members can provide input prior to the Spring AC meeting on COVs that are coming up; these include NCAR and the facilities section in the early spring, along with Ocean Sciences in late spring or early summer. This will effectively be the first COV for the science programs since *Sea Change*. Questions can be directed to the relevant DDs. At least one

AC member is required to be a COV liaison, who can participate in the COV meetings, discussions, examination of the jackets, development of recommendations, and engendering discussion within the AC, Dr. Borg said.

In response to a question from Dr. Constable, Dr. Houtman said his office is working with the community and the Marine Science Research Oversight Committee to identify options for replacing the Langseth. A solicitation is out and a workshop or ideas lab is being planned for early 2019 to explore options. Dr. Easterling said he understood the community to be relatively slow to engage on critically needed help finding a replacement for the Langseth and asked interested AC members to help move the community forward. Dr. Houtman said the community has not accepted that the status quo is not the future and needs to identify viable alternatives.

AC/GEO voted to accept the COV report.

Discussion of Draft Report, 21st Century Geosciences (Continued)
Dr. Hodges asked committee members to divide into groups and review their earlier work on this topic and provide characteristics of the hypothetical ministry that would achieve the adjectives compiled during the prior discussion.

Group 1developed ministry's general attributes. It decided the ministry has a mission to support visionary, innovative, progressive, relevant, and impactful science. To execute this mission the organization aims for excellence in the science it supports and in its own staff, policies, and procedures. The organization promotes an inclusive and diverse working environment for itself and the research teams and organizations it supports. Decision making is open and transparent to build and maintain trust with the community it serves. It manages resources in the most efficient, nimble, agile, well-organized way. It is funded on a multi-year basis to plan strategically.

Group 2 focused on excellence in the peer review system and the organization. Key attributes were transparency across the community to understand the attributes and motivation of funded proposals. Being guided by community priorities, such as decadal surveys. Clarity of instruction to reviewers to yield the desired outcomes. For excellence to be defined, evaluated, and assessed. Retain flexibility to look at high-risk, high-reward proposals that are multi- or trans-disciplinary. Organization employees with strong leadership and management skills who are active in decision-making. The organization needs to be able to embrace risk and should be organized around problems, not disciplines.

Group 3 centered on diversity. The organization needs to have an explicit statement of values with a consistent message, a long-term commitment, and a sustained messaging about diversity. Specific opportunities need to be defined and tracked. There needs to be a close, sustained mentorship for students. Diversity in leadership is also needed.

Group 4 discussed innovation and agility. The organization needs financial flexibility and to be realistic about the role of small and large grants to support innovation. It should also accept risk without the promise of high-value returns to not diminish the potential for innovation. There should be equitable access to data that can support innovation to make sure smaller institutions have opportunities to join with larger labs. There should be investment in NSF staff to more

properly manage risky and challenging proposals that may cross disciplines, with leadership empowerment and time to support innovative proposals. Advice should be sought from the community broadly to identify what is meant by innovation, with an openness to different perspectives on measuring how signifiers of excellence and innovation are recognized.

Dr. Hodges concluded the session by saying significant progress had been made on ascertaining the main characteristics important for any organization that supports rapidly changing science.

Meeting Adjourns for the Day

Thursday, October 18, 2018

Division Reports from Virtual Subcommittee Meetings: Atmospheric & Geospace Sciences
Dr. Bamzai, AGS Acting Division Director, discussed the division's wildfire research. She highlighted:

- Climate variability and change is lengthening wildfire season—increasing damage to homes, businesses, air quality, wildlife, and habitats.
- In 2017, several California wildfire episodes each exceeded $1B in losses.
- AGS supports studies to examine how wildfires are impacted by weather and how they drive their own weather.

Dr. Bamzai discussed the Western Wildfire Experiment for Cloud Chemistry, Aerosol Absorption and Nitrogen (WE-CAN), which ended in September:

- Understanding the chemistry in western wildfire smoke has major ramifications for air quality, nutrient cycles, weather and climate.
- Project characterizes the emissions and first day of evolution of western U.S. wildfire plumes.
- Three sets of scientific questions related to fixed nitrogen, absorbing aerosols, cloud activation, and chemistry in wildfire plumes.
- Data were collected from the NCAR/NSF C-130 research aircraft.

She followed with numerous personnel updates, which have entailed considerable onboarding and mentoring. Updating NCAR, she noted:

- UCAR will continue management of NCAR, effective October 1, 2018
- Additional NSF funding
    - Renovation of NCAR Research Aviation Facility
    - Essential maintenance at Mesa Laboratory
    - Early career visitors' program

She noted that NCAR leadership is in transition, with the Director stepping down and the death of the Deputy Director and Chief Operating Officer (COO), Dr. Thompson.

She concluded her presentation with the sunsetting of the Sondrestrom Research Facility:

- After 35 years of exemplary science accomplishments Incoherent Scatter Radar (ISR) operations end Mar 2018
- Management of the site is now being handled by CPS

    - Environmental and engineering assessment report has been delivered
    - PIs being supported in retrieving their instruments over the summer
    - Site has been winterized and is being monitored
- Future of the site will be based upon Portfolio Review recommendations, environmental and engineering assessment, and interactions with the Greenland Self-rule government
- Expect issuing final decision in the coming months

Dr. Semeter continued the AGS presentation by reviewing a teleconference that focused on the geospace section, including the future of CubeSats, an innovative initiative started by a section head that now cuts across NSF and is being recognized for engineering research. The main commercial applications have to do with observation and present data sets that are an opportunity for Earth Sciences. The teleconference also discussed faculty development in space sciences. There was some pushback that the program was developed in response to a workforce crisis of sorts in the geospace sciences. Dr. Semeter said he believes it was a well-justified, proactive program that has paid off. He concluded by discussing the Space Weather Action Plan to prepare the nation for threats related to space weather, which he said is receiving bipartisan support. Dr. Bamzai added that there will be a COV in spring 2019.

Discussion

Dr. Easterling remarked on the growth of geospace science over the past year and a half and said NSF is paying a lot of attention to its expansion.

Division Reports from Virtual Subcommittee Meetings: Earth Sciences

Dr. Patino discussed personnel changes for bringing the division to full staffing levels. She also said the 15-year EarthScope program has been completed. Dr. Constable discussed the competition for the management and operation of the National Geophysical Observatory for Geoscience (NGEO). Reviewing SAGE/GAGE, she said it includes:

- Instrumentation, data management, field and logistical support, and education and outreach programs
- Supports over 20,000 unique users and 100 field experiments worldwide yearly
- Supports research funded by:
    - Most Division of Earth Sciences (EAR) science programs
    - Prediction of and Resilience against Extreme Events (PREEVENTS)
    - Programs in OCE, AGS, and OPP

Noting that the awards have been concluded, she described the SAGE scope:

- Instrumentation Services
    - Global Seismographic Network
    - Portable Seismology
    - Polar Services

There are data services through education, outreach, and workforce development. The new award, for $18M in FY 2019, with a total of $93M for 60 months includes:

- Next-generation instrumentation for full-wavefield experiments and rapid response
- New Broadening Participation in the workforce Initiative.

Turning to GAGE capabilities, she described a new foundational capability, the Network for the Americas (NOTA). Under new frontier capabilities she listed next generation geophysical instrumentation and geodetic data services. Moving forward, NSF will provide $13.2M in annual support and NASA $1.1M.

Dr. Patino continued with a discussion of a pilot program for broadening participation in EAR, in response to a COV last year. A committee was formed to develop criteria to select two institutions and the individuals who would participate in these visits in FY18. It recommended visits to the University of Texas at El Paso, New Mexico State University, and Georgia State University, which were carried out in September 2018. Dr. Patino said the visits were highly valued by the institutions and the Program Directors. A visit to an historically black college and university (HBCU) is anticipated for the spring.

Dr. Constable concluded by describing an EAR decadal survey: Catalyzing Opportunities for Research in the Earth Sciences (CORES). The charge is to identify priorities and strategies for EAR's investments on research, infrastructure, and training in the coming decade. The report will provide:

- A concise set of high-priority scientific questions
- Identification of the infrastructure
- Discussion of the current inventory of research
- Analysis of capability gaps
- A discussion of how EAR can leverage and complement the capabilities, expertise, and strategic plans of its partners

She presented the CORES committee membership list, which AC members can provide input on, and said the survey will set the trends on how limited resources are spent and is therefore something the community should care about.

Discussion

Dr. Hodges said the decadal survey is a once-in-a-lifetime opportunity to think about EAR and encouraged everyone involved in EAR to consider if the CORES committee will be perceived by the community as representative. He also expressed his hope that there would be an opportunity to submit white papers to the committee. Dr. Patino said there would be multiple venues for community input in different forms. AC/GEO members should encourage their Earth Sciences colleagues to be engaged in the process.

Dr. Easterling noted the importance of the survey for SAGE AND GAGE and how the foundation is preparing the CORES committee to help provide guidance. Dr. Patino said the CORES charge includes looking at infrastructure capabilities and whether they align with scientific priorities.

Dr. Borg said Congressional staffers and committees look closely at decadal surveys, which they see as a sign of interaction with the community. The NSB is looking closely at management structures and pressed NSF on why there wasn't one management structure for SAGE and GAGE, with their similar instrumentation. Also, in parallel with the decadal survey, EAR has engaged an interagency group to help inform the committee.

Dr. Patino said there are pieces of SAGE and GAGE essential to the mission of other Federal agencies. If the scientific community has not listed those areas as a high priority, it is prudent to have these agencies pick up some funding and they will be having those discussions. Dr. Borg said the discussion with the other agencies Dr. Patino described will produce input the decadal survey can take that into consideration.

Dr. Constable said there are also other infrastructure issues that should be highlighted through the decadal survey, like the Consortium for Materials Properties Research in Earth Sciences (COMPRES).

Dr. Kempton asked where the decadal survey committee would get its information. Dr. Patino said some communities have produced white papers and workshop reports. The committee will do an inventory of what they are missing and will reach out to specific communities. There will be calls for information through professional meetings and possibly workshops when more details are needed.

Dr. Easterling said there is a persistent line of questioning from the NSB about why NSF invests in facilities for as long as it does. Everyone should be ready to justify investing in an NCAR, for example, for over 50 years, demonstrating that the large facility investments are a risk worth taking and that the returns are worth the investment.

Dr. Borg said Dr. France Córdova was concerned when she became director about the amount of money going to the NAS and whether NSF was getting a sufficient return. That led to an emphasis on how NSF looks at funding the consensus studies the Board does and if it can be done with other instruments the National Academy offers for quicker turnaround reports. NSF was particularly concerned about the input NSF has to the charge. The requirement for strong interaction with the community and multiple ways for input on decadal surveys has been emphasized to the Academy, he said. The requirement for community interaction has been strengthened and NSF will be watching. Dr. Patino emphasized that the decadal survey is about scientific priorities for the division as a whole, not just the facilities.

Dr. Hodges said NSF is paying for the study and should have more than a superficial say on how it is done. There should not be a certain group designated to write a white paper; it should be anyone who wants to write a white paper, with the committee actually responding to community input. It is important these ground rules are made very clear to the committee. Dr. Borg said that has happened. Dr. Constable said the community should be driving the community input. The OCE decadal survey was successful because the committee accommodated the community input. If the community is not interested in this process, it is not going to go well. Dr. Hodges said there are clear ground rules about how to get input from the community. Most or none of those on the committee have been part of such a survey before and will need mentoring to help them do that.

In response to a question from Dr. White about the campus visits, Dr. Patino said data related to EAR was examined, regardless of academic department. The primary target was New Mexico State, she said. In response to a question from Dr. Kempton about visit outcomes, Dr. Patino said

the idea was that in making departments stronger, strengthening their research, and highlighting their opportunities as institutions, departments will perhaps become more diverse.

Division Reports from Virtual Subcommittee Meetings: Ocean Sciences

Dr. Quinn, Director, Division of Ocean Sciences (OCE), provided a facilities update on Regional Class Research Vessels (RCRV):

- Research vessel (R/V) Taani:
  - Keel laying (November 2018)
- RCRV2 (new award)
  - East Coast Consortium (The University of Rhode Island (URI) lead)
- RCRV3
  - New solicitation expected, pending appropriation

Dr. Quinn also presented the OOI Update from 1.0 to 2.0:

- OOI 1.0: The Consortium for Ocean Leadership (COL) is finishing activities on a No-Cost Extension (NCE) until June 2019
- OOI 2.0: WHOI as new lead, October 1, 2018
- 5-year Cooperative Agreement (CA) w/WHOI @ $44M/year
- 5-year renewal possible

Continuing with OOI 2.0, Dr. Quinn highlighted:

- The Same Marine Implementing Organizations (MIOs)
  - The University of Washington (UW), Cabled Array
  - WHOI, Coastal Pioneer & Globals
  - Oregon State University (OSU), Coastal Endurance
  - Rutgers, Cyberinfrastructure
- Data Delivery Changes
  - Quality Assurance/quality Control (QA/QC) w/MIOs
  - WHOI Data Integrator, Raytheon SubAward
- Data Delivery & Cyber Infrastructure Committee
  - 1st in-person meeting, October 2018
  - Reports & external evaluations in 2019

Next, Dr. Quinn discussed the $352M NSB request for renewal for the drill ship *JOIDES Resolution* Science Operator, Texas A&M (60 months, ending September 2024). All signs are looking positive for renewal, he said. He also provided staffing updates, including new POs, Program Lead changes, and MGS Section Head recruitment. He presented new and pending NSF solicitations and DCLs, including:

- Understanding Rules of Life (Solicitation)
  - Synthetic Cell / Epigenetics
- Mid-Scale (MS) Infrastructure (DCL)
  - MS1, $4 to $20M
  - MS2, $20M to $70M
- Navigating the New Arctic
  - Solicitation out soon

In conclusion, he discussed AC/GEO member participation in a OCE (Marine Geosciences Section (MGS) and Ocean Sciences) COV, late spring/early summer, 2019, and for a committee being put together next year for a 40-year Long-Term Ecological Research (LTER) review.

Discussion
Dr. Kempton asked whether the COV will consider funding in the context of *Sea Change* and any impact early career researchers. Dr. Quinn said that would be part of the COV review.

In response to a question from Dr. White about whether the lifetime of the *JOIDES* was discussed, Dr. Quinn said yes, explaining the renewal was based on the next 5-years' use of the ship and that the community is beginning to look at the post-drilling discovery program after the *JOIDES*. An audience member provided details on ship upkeep and community involvement.

Report on Upcoming AC-OPP Meeting
Dr. Falkner said AC-OPP will meet November 1 and 2 with a new chair, Dr. Thomas Weingartner, an oceanographer recently retired from the University of Alaska at Fairbanks. In preparation of AC/GEO's revisit of DE, AC-OPP has looked at what it can provide as assistance. There are Academy studies that are decadal in nature: *Future Science Opportunities in Antarctica and the Southern Ocean*; *The Arctic and the Anthropocene: Emerging Research Questions*. She also mentioned the decadal survey for astronomy and astrophysics that is underway now. AC-OPP is working on a high-level summary of these efforts, which has involved members pushing outside their expertise to understand the breadth of the purview and the difficulty of setting priorities and should be available for AC/GEO by the spring meeting.

Presentation on GEO Success Rates
Dr. Borg said success rates for research grants are not a very useful metric for NSF. The data come from systems designed for financial businesses rather than programmatic evaluation. He presented a graph showing a higher success rate for GEO compared to NSF that some interpret as GEO being less competitive, which he termed an inappropriate conclusion. One of the many other factors is the increasing burden on staff and the community with the increasing number of proposals, adding that with the change to no deadlines, e.g., GEO has tried to avoid researchers putting in effort that will not bear fruit.

As another example of misleading data, he said in some areas parallel proposals are offered from several institutions for one project, producing three to five declines or as many awards, though there is only one project. Counting proposals in this case does not present a picture of decisions on ideas. He listed what has been done to reduce the burden:

- Practices include:
    - Suspending deadlines.
    - Pooling proposals that use the same facility.
    - Providing ship schedules and other logistics information so proposers can better time requests.
- External effects
    - Proposer "self" limitation based on prior facility commitments.
    - Long lead times for access to certain facilities means commitment required for longer time period.

    - Community organization around themes or campaigns.
- Other factors
    - Lots of multi-institution collaborative proposals.
    - What's meaningful, proposal, or project-based rates?
    - NSF systems calculate success rates on proposals, not projects.

Dr. Borg presented information from the NSF business system showing proposal counts. For 2016, there were 45 competitive EAGER awards for $5.1M relative to the GEO total of 1,315 awards for $580.7M available to all of the (non-facility) GEO research programs. There were also 45 RAPID awards for $3.3M. In general, RAPID and EAGER proposals are rarely declined because an informal discussion is required ahead of time and it is rare for a proposal to be submitted after a PO has said it is not suited for RAPID or EAGER.

Dr. Borg concluded by saying that concerns about whether a class of proposal is being disadvantaged —e.g., whether single-investigator proposals received short shrift because of an emphasis on interdisciplinary research that usually has multi-institution collaborative proposals —are appropriate to pose to COVs. If the questions are developed ahead of time, POs, staff, and others can use available data sets more effectively to address the concern, something not otherwise easily done.

Discussion

Dr. Hodges referenced the earlier discussion about whether EAGER is a venue for non-solicitation-driven proposals. The numbers that Dr. Borg presented show EAGER is not used that way. The proportion of funding is small because PMs are concerned there is no review process, they do not want to spend too much, and are limited to 5 percent. If the committee wants to recommend more opportunity for proposals that are not as much multi-institutional as multi-PI, either EAGERS will have to be viewed differently, or a new program would be needed for those proposals. Dr. Falkner said EAGER had come up in the context of finding funding to pull together communities to crystalize their science, rather than implementing a project.

Dr. Borg said NSF is supposed to be open to proposals that fit within NSF's very broad mandate. Theoretically, NSF welcomes proposals submitted only under the Proposal & Award Policies & Procedures Guide (PAPPG). It is an open solicitation and it is up to NSF how determine how to review it. That takes openness by POs and the community thinking more broadly, still submitting when not fitting into a pigeonhole represented by a solicitation.

Dr. Patino said there is a new tool, Research Advanced by Interdisciplinary Science and Engineering (RAISE), which replaced Integrated NSF Support Promoting Interdisciplinary Research and Education (INSPIRE). But it is the PI's responsibility to sell their idea because there is a high threshold on getting that type of idea that does not fit any single solicitation; multiple programs must agree to take on the proposals.

Dr. Hodges said when getting ready to put together a proposal, one is confronted with FastLane or Grants.gov, which want to know what program is being submitted to. Some with less experience do not know they can submit to GEO, for example. This may be a communication issue AC/GEO can address.

Proposals to RAISE, RAPID, AND EAGER have to be for projects that can't be reviewed by normal processes, which are able to review almost every idea, an audience member said. Early-career researchers don't always know they can reach out to NSF Program Managers for guidance, she added.

Dr. Lynch said the previous comment supports making mentorship more institutionalized. Some early-career researchers have an advantage over others, depending on the information received from their mentors about contacting a Program Manager.

Preparation for Meeting with the NSF Director and Chief Operating Officer
The committee developed a list of questions it would pose to the NSF Director.

Meeting with the NSF Director & Chief Operating Officer
Dr. Hodges welcomed Dr. Córdova to AC/GEO and briefed her on the committee's work to update DE with *21st Century Geosciences*. In that context, Dr. Lynch asked if the report would be more useful if the committee engaged explicitly with the Big Ideas or if it did that implicitly and stayed on a strategic level. Dr. Córdova said she did not have an opinion but hoped the report would touch base with the relevant Big Ideas. Only a small part of the budget is going to the Big Ideas, she noted. The real change brought on by the Big Ideas is a more strategic approach for NSF. In addition to continuing NSF's signature bottoms-up approach to funding curiosity-driven research, the times call for being action-oriented and purposeful about where to make investments —a combination between a bottoms-up approach and a top-down strategic approach. The Big Ideas are part of this strategic approach, as is talking about balance, as in the mix of small and large facilities and the mix of investigator-driven projects and bigger projects. NSF looks to the AC to tell NSF as, as *Sea Change* did, if the balance is off. Dr. Hodges said the geosciences are evolving in the direction of the Big Ideas, with convergence a fundamental part of geoscience research.

Responding to a question from Dr. Paola about what makes a report impactful for her, Dr. Córdova started by recommending the AC meet with Dr. C. Suzanne (Suzi) Iacono, who heads OIA, who did a study that tries to determine the elements of a successful report (*Impact Assessments of NSF Awards to the National Academies of Science, Engineering, and Medicine*). One of the findings was that reports with well-focused and on-point actionable recommendations are preferred by NSF. It is also important for the committee to touch base with the customers for their report and to be clear about the initial charge. Other recommendations from the report, she said, include: novel or insightful recommendations can spur change; timing is important; and strong, distinguished, and engaged chairs and committee members help create impact; projects with clear, focused project descriptions and charges are more impactful; significant community interest improves the likelihood of impact. Dr. F. Fleming Crim, Chief Operating Officer, added that it was important to keep in mind the audience, noting that NSF also uses the reports externally to show where the community stands on an issue. Dr. Hodges said AC/GEO has extensively discussed the audience. Also, the report can help the community itself understand where the field is going.

Dr. Córdova noted the role other agencies have in the geosciences and said it would be nice to know the AC's feelings about collaborations with those other agencies, while still keeping the report focused on how NSF can make essential contributions.

Dr. Kempton asked about the feedback AC/GEO can provide the committee developing the decadal survey for EAR. Dr. Córdova focused on facilities and changing technologies. It is important to focus on what is needed and how new technologies such as drones and 3D printing allow researchers to do more with less expensive equipment. She added that having every part of GEO do its own decadal report can make it difficult to set priorities. Dr. Hodges said the decadal survey will be a stressor on the EAR community, which has never had to deal with prioritization, but he did not want to see a panic attack among the community. Dr. Córdova said there will be a panic attack. To be useful, it has to make tradeoffs and set priorities for declining, steady, and increasing budgets. Dr. Crim added that it less useful to assume 5 percent annual growth for the next decade than to assume a flat budget. Dr. Córdova said it is also useful to address one-time funding increases, which can lead to mistakes if it isn't thought trough. She recommended examining the charges for the astronomy decadal surveys. The EAR decadal committee would also want to know about the AC's interest in including social issues, she said. Dr. Constable said she hoped the committee would take these issues seriously, including diversity, harassment, and bullying. She also expressed concern about representation across the breadth of science in EAR. She recommended harnessing the panic to get people to participate and asked what else can be done to get broad representation. Dr. Córdova said it was important to have the right person chairing the committee. Also, lessons can be learned by talking to past chairs of decadal reviews. Retuning to cultural issues, she said it is important to include it in the charter. Rather than fearing panic in the community, she advised looking at the good outcomes the decadal reviews have and their influence on Capitol Hill. It is also important to look at how existing projects are being managed and not to propose new ones if some are in trouble.

Turning to the Antarctic and Arctic, Dr. Córdova previewed her upcoming trip to the Second Arctic Science Ministerial in Berlin. She also discussed AIMS, saying it was getting support in Congress. The biggest challenge is how to do science while building. Dr. Falkner discussed the overlapping membership between AC/OPP and AC/GEO and discussions between the two.

Dr. Córdova returned to the issue of convergence, describing a workshop on the topic she will be attending soon that will have participants from government, universities, foundations, and companies. Convergence distinguishes what is being done today vs. yesterday and she looks forward to seeing how it is addressed in the AC's upcoming report. Dr. Hodges said cross-disciplinary work has always been part of the geosciences and will be a big component of the report. Dr. Córdova noted that the current emphasis on convergence comes out of the combination of biology and engineering. She went on to say that NSF first talked about convergence in the early 1950s around the issue of bringing the social sciences into the portfolio.

In response to a request from Dr. Easterling that she talk about convergence as a way of accelerating science, Dr. Córdova said in the present action-oriented climate, convergence accelerators were taking up some of the Big Ideas that are ready for a fast track and can produce deliverables. Dr. Crim added that convergence accelerators are an excellent mechanism for connecting with industry.

Dr. Kempton raised the issue of the long timeframes sometimes needed for geoscience research and asked if it was advisable to explain the need for longer-term investments. Dr. Córdova responded that it was never a waste of time to state the obvious. But she also reiterated the importance of finding cost saving new technologies. NSF does not necessarily have to be tied to spending lots of money forever, if you can divest yourself of old technologies and continue to do the research because you have much newer technologies that can supplant it, she said. It is very important to use examples of where long-term measurements are essential. It's just that it does not need to cost tomorrow what it costs today.

Discussion

Following the Advisory Committee's meeting with Dr. Córdova, Dr. Borg briefly discussed restructuring in the Office of the Assistant Director. He said a recruitment is underway for the position of Senior Advisor for Facilities, within the office of the Assistant Director. The person in this position will be a liaison between managers of facilities within the organizations in GEO and the Director's Chief Officer for Research Facilities, which is now a required position. The Director decided the most effective way of implementing that is to have a Senior Advisor for Facilities within the infrastructure-rich directorates. That person works in an advisory capacity and maintains awareness of upcoming issues to effectively communicate that with the front office. This is a sign, he said, that Congress is recognizing that the significant investments made at NSF might have to be looked at somewhat differently than grants programs, where the number of grants can be adjusted yearly. Dr. Easterling added that over the last year and a half, GEO has had a large number of facility financial renewals and major construction projects, such as AIMS and RCRVs. It is in part because of this large amount of activity requiring NSB approval that the Director's office has seen the need to become more organized at her level and that that would filter down through the facility-heavy directorates.

Working Lunch: Discussion of Draft Report, 21st Century Geosciences (continued)

Dr. Hodges asked the AC to continue its conversation about *21st Century Geosciences* in light of their meeting with Dr. Córdova and her advice that the most impactful reports have specific actionable items. He framed these generally as suggestions that GEO look into possibilities. For example: GEO should look for ways to create permanent structures that invite multi-disciplinary kinds of projects. Dr. Easterling suggested these take the form of a suggested set of best practices. Dr. Hodges suggested passing the recommendations by Dr. Easterling before the report is finalized so AC/GEO does not ask for something impossible. Dr. Easterling responded that it is important to be innovative and take risks, without being afraid of change.

Dr. Paola said he heard the Director refer to specific priorities for different budget scenarios. Dr. Hodges said that comment by Dr. Córdova referred to the EAR report. Dr. Constable added: That's what she said, but you'd be delusional if you think that's what she meant. If AC/GEO is going to make recommendations that are to be taken seriously, you have to think about the budgetary consequences, she added. Dr. Hodges said prioritizations in the EAR decadal survey will result in budget adjustments but if AC/GEO suggested, for example, spending as much on multi-disciplinary projects as individual investigators, that would likely not be done. Dr. Constable agreed but recalled an earlier discussion about AC/GEO potentially advocating a larger GEO budget. She said it was necessary to be realistic about that. Noting that most parts of

the GEO budget decreased, she recalled that the committe had hoped to set the stage for the new world of science, where there's room for an enhanced budget for things we think of as important. Dr. Easterling said the budget decrease for the programs reflected a move to the Big Ideas, which are open to GEO. DE included implicit thinking about budgets in its research imperatives and priorities. He said it would be helpful for the new report to signal how the availability of funds might shape NSF's thinking about implementing AC/GEO's priorities. NSF would use this as a guideline in setting priorities. Dr. Constable said the issue was how strongly to word support for a balanced portfolio. Dr. Easterling said that was the committee's responsibility. Dr. Lynch said the Arctic portfolio review might create a fuzzy pie chart showing the preferred balance.

Dr. Paola recalled Dr. Córdova saying the most useful reports have actionable, specific recommendations. Also, the committee should clarify the distinction between interdisciplinary research of the kind that could come from a team of people who hatch an idea at a bar from named, clearly delineated projects. Also, it would be useful to have information on how NSF distributes money between single-PI and multi-PI projects. Dr. Heald said the AC should think about making the mechanism for funding interdisciplinary work more apparent or how to enable it. The AC does not have the information to think about balancing the portfolio. Dr. Easterling said *Sea Change*, with its strong recommendations, was prompted by a real and pressing problem; the balance of portfolios is not a problem of that magnitude.

Dr. Borg said he took from Dr. Córdova that it was more important to think about budgets and actionable priority setting with decadal surveys. He stressed the importance of looking beyond what is actionable and not losing the aspiration for advancing the progress of science. The decadal survey report is the vehicle for balancing. It could be very effective to focus on developing the processes for making wise decisions with the community about balance.

Dr. Hodges said National Academy reports set research priorities, whereas the AC/GEO report is more about process, function, and protocol within GEO, where it looks at problems and conundrums and figures out the best way to solve them with groups of people of people of all sizes. At the same time, he said, we want to express how excited we are about where the geosciences are going and why it demands that kind of broad portfolio approach.

Dr. Lynch said AC/GEO was also being asked about, and should not shy away from, the balance between large interdisciplinary, multi-investigator efforts and narrow discipline-specific efforts. Dr. Constable said a way to address that is by endorsing the Big Ideas and participating. She does not know what the balance should be, she said, and found it distressing *Sea Change* limited facilities spending to a fixed percentage. That balance setting is not the job of the new report. Dr. Easterling distinguished between investments in interdisciplinary research versus core disciplinary research versus research and facilities. Dr. Constable responded that these are conflated in the community, where they see largely interdisciplinary solicitations, such as Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) and PREEVENTS, and say that does not fit what they do. Dr. Easterling agreed, adding that it was due to NSF efforts that these interdisciplinary programs exist, which are not easy to administer. Dr. Constable said the issue is the specificity of the interdisciplinary programs. She argued for what Dr. Hodges advocated, a process that allows the kind of interdisciplinary research that is not

prescribed by the rest of the community. Currently, the only way to do that is to submit an unsolicited proposal and name a sympathetic PM.

Dr. Paola said AC/GEO's report needs to decouple named targeted projects and interdisciplinary research. Dr. Constable asked if he wanted core or interdisciplinary research. Dr. Paola said AC/GEO could say its desire is that NSF develop a mechanism for submitting interdisciplinary research not in a named program.

Dr. Borg brought up Arctic and Antarctic system science. When he started as head of Antarctic sciences, he was often asked to create an Antarctic System science program. He also heard from those doing Arctic science in the disciplinary side who felt crowded out. He had said no to creating the new program because he expected the disciplinary programs to consider things across their programs. Solicitations were changed to make this easier, but he almost never saw proposals across more than two programs because there was not something that said the number of programs is not a concern. Those programs are not aimed at a topic, he said. Dr. Lynch said sometimes they have been aimed at a topic, other times not, which makes clarity a critical point. Arctic system science lowered the bar by requiring contact with just one PM, but there were times when it was very specific and narrow about what it was funding. So, having interdisciplinarity as a value, as opposed to having specific projects, will provide critical clarity. Dr. Hodges agreed, adding that the Continental Dynamics program is an example where structural obstacles were set up against interdisciplinary work. Within two years, the community got the message from the PD and panelists that they were looking for projects involving seismology in the shallow Earth. Dr. Easterling said in numerous cases the core programs have leveraged some of the interdisciplinary programs, so there is often collaboration between the disciplinary research and interdisciplinary programs, which is strongly encouraged and is expected with the Big Ideas.

In response to a question from Dr. Paola about money distributed among PI group size, Dr. Borg said he used the number of people listed on the front page of a proposal or group of proposals. In that case, a project is more than one proposal, he said, agreeing with Dr. Paola, but a group size could be in one university, and might be only one proposal. He noted that Dr. Paola wanted the analysis independent of that distinction. Dr. Paola also asked for information about interdisciplinary proposals that are not part of the named programs. If it is never more than two, as indicated, the report should say why they aren't being written. Dr. Lynch said it'll never be known how many are not being submitted because of the perceived hurdles. A recent survey of Arctic PIs found almost all respondents lacked confidence in being able to submit cross-disciplinary proposals. We need to be aware of the innovation not being captured, she said.

Dr. Hodges said there are individual investigators who do multi-disciplinary proposals and these would not be captured if only looking for those with three to five investigators. The structure of long-standing programs might have to be rethought, he said. But whatever structurers there are need to be continually reviewed. Dr. Easterling said NSF's rule is that nothing is forever. With flat budgets, if you want to do something new, you have to stop something. Dr. Bamzai said PDs do shop around proposals they receive that do not fall directly in their own program. At the program level the database has information on PMs for things that were co-reviewed that belonged to another part of the foundation. The PI has the option of selecting what program they

think it belongs to and the code for the non-leads. When it arrives in FastLane it goes to the lead and then it is sometimes reassigned to another program. Those proposals may not be as successful because they have to go to two panels. A lot depends on the PD, she said.

Dr. Hodges said he hears from the community that the structures are sometimes set up to make it difficult. But it can be made better with help from everyone all the way through the system.

Dr. Kraft said it would be helpful to reexamine who the audience is for AC/GEO's report as opposed to the audience for the EAR report. Dr. Hodges responded that the primary audience for the EAR report is EAR, the secondary audience is the administration at GEO, and the tertiary audience is the Director. Another audience consists of those writing proposals who may hew to the major research imperatives in the report. For the AC/GEO report, the primary audience is Dr. Easterling and Dr. Borg. The Director will hopefully also get something from it and have a better appreciation for the geosciences. Dr. Hodges said he hoped more people will read the new report than DE. Dr. Easterling said NSF is often asked by the Office of Management and Budget (OMB) to say where it gets the information used to arrive at budgetary decisions. DE's recommendations have been used to develop research priorities. There is a close correlation between DE's frontier research recommendations and the emerging set of geophysical research interests in CoPe. Turning to the EAR report, he said that Congress holds NSF's feet to the fire on the recommendations that come out of National Academies' reports.

Dr. Hodges turned to funding for graduate students. Universities increasingly view teaching assistantships (TAs) as strategies for educating undergraduates, not for supporting graduate students. Because of the economic incentives for hiring instructors in most departments there is a drop in available TAs. With graduate students taking longer to complete their doctorates, the only way to provide them the additional support they need is through fellowships and grants. Graduate fellowships support only a tiny proportion. It's becoming a crisis he said.

Dr. Patino said that to provide more funding the committee must recommend what to cut. She encouraged the AC to promote the submission of applications to the graduate research fellowships because the number of fellowships per discipline are allocated based on the number of submissions to those disciplines. Education is also needed on the changes in the graduate research fellowship program. Graduate students can apply only once. Undergrads and non-students can apply for the following fall. Graduate research fellowships are focusing on incentivizing students to go to graduate school and finish their degrees, not to sustain the 7-year Ph.D. program. There is also a trend to more proposals coming in with a post-doc in the proposal instead of a graduate student. NSF has never sent a message that it is not supporting graduate students in research grants; the majority of graduate students NSF supports is through research grants.

Dr. Easterling said as university Dean he developed a mentoring system to help graduate students with their NSF fellowship applications that quickly improved the success rate. NSF, he said, could put together advice on best practices for universities on mentoring graduate students with fellowship applications. Dr. Riser said his institution has seen similar success with an elective course for first-year students to help write their NSF proposals. But even if NSF doubled the number of fellowships, it would not solve the problem; it has to come out of program funds.

Dr. Easterling said NSF is intensely discussing giving larger grants, accepting lower success rates. Dr. Riser asked if Congress would support more funding for graduate students. Dr. Borg said this is already part of regular discussions, but some on Capitol Hill want to be deaf to geosciences because it is equated with climate change policy. If NSF had better stories to tell on the Hill of students who worked in industry, it would play well. Dr. Bamzai said the National Center for Science and Engineering Statistics gives data on where students go when they leave school. Also, AGS is considering reactivating a post-doctorate research fellowship program.

Dr. Paola raised the issue of NSF not funding faculty salaries. Dr. Easterling said he did not know how the programs would view becoming more stringent on faculty salaries but said the issue could be explored. Dr. Riser said his university decided to not replace people funded with soft money when they retire because it requires six months of writing proposals to get funding for 12 months. Dr. Constable said views vary at her institution. Some survive on 25 percent hard money. Others in 5 percent-success-rate fields are not getting summer salaries. They can only fund graduate students if they bring a 3-year Graduate Research Fellowship and the department chair finds funding for the other two years. The number of Ph.D. students is down and the number of master's students, who mostly pay for themselves, is up. Dr. Easterling said NSF tries to hire ocean science research faculty on soft money as POs. But sometimes the home institution cannot provide the NSF-required 10 percent match. Dr. Quinn asked about the bang for the buck from salary support. Dr. Bamzai said she has been sympathetic to soft money researchers in some cases. Dr. Lynch, who said she doesn't need to ask for summer support in her grants, has to explain that she will be involved in the project. She recommended providing information to PMs to help them understand that circumstances differ. Dr. Hodges said this is an even bigger problem at NASA, where panels must assure the effort matches the money requested for the salary. Dr. Easterling said the difficulty faculty have covering the summer salary is pushing 9-month faculty contracts, which increases the amount NSF must pay for a summer month. Dr. Hodges said there are underpaid faculty who can't have any graduate students if they put their own salary in the proposal. And many faculty members write proposals just to fund graduate students and for individual investigators, with the large share of the cost going to student support. One solution would be to use block grants to institutions for graduate students.

Wrap-Up and Action Items

The AC previously discussed two action items:

- Future AC-GEO agendas will include time to discuss upcoming COVs scheduled to report at future AC-GEO meetings.
- The committee should consider making specific recommendations about publicizing how interdisciplinary proposals can receive appropriate consideration.

The next AC/GEO meeting will be held April 10-11 and the fall meeting is scheduled for October 16-17.

Dr. Hodges thanked everyone and ended the meeting.