

Advisory Committee for Geosciences (AC/GEO)
April 25-26, 2018
Meeting Minutes

NSF Attendees:

Scott Borg
Bill Easterling
Kelly Falkner
Melissa Lane
Richard Murray
Lina Patino
Paul Shepson

AC/GEO Members Joining by Teleconference:

Kip Hodges (Chair)
Catherine Constable
Jose D. Fuentes
Gregory Hakim
Colette L. Heald
Pamela Kempton
Kaatje Kraft
Amanda Lynch
Sumant Nigam
Chris Paola
Shirley A. Pomponi
Joshua Semeter
Cindy Lee Van Dover
Jeffrey Welker

Wednesday, April 25, 2018

Welcome & Introductory Remarks

Dr. Hodges opened the teleconference meeting and turned it over to Dr. Easterling.

Brief Update on NSF GEO Activities

Dr. Easterling said NSF funds 2,000 institutions; evaluates 49,000 proposals per year; supports 359,000 people; funds 11,000 awards; has given out \$1.2 billion to support science, technology, engineering, and math (STEM) education and workforce development, an increasing foundation interest; and noted there have been 231 NSF-funded Nobel Prize winners.

He said the NSF Strategic Plan for Fiscal Years (FY) 2018-2022 has three goals:

Goal 1. Expand knowledge in science, engineering, and learning.

- Objective 1.1 – Advance knowledge through investments in ideas, people, and infrastructure.
- Objective 1.2 – Advance the practice of research.

Goal 2. Advance the Nation's capability to meet current and future challenges.

- Objective 2.1 – Support research and promote partnerships to accelerate innovation and provide new capabilities to meet pressing societal needs.
- Objective 2.2 – Foster the growth of a more capable and diverse research workforce and advance the Nation's scientific and innovation skills.

Goal 3. Enhance NSF's performance of its mission.

- Objective 3.1 – Attract, retain, and empower a talented and diverse workforce.
- Objective 3.2 – Continually improve agency operations.

Dr. Easterling highlighted the recent congressional appropriation for the remainder of FY 2018. NSF is still deciding how to allocate this funding. The agency was given a plus-up of about \$300 million, mostly reflected in the Research and Related Activities budget line. It will be spent strategically with an emphasis on catching up with facility and large infrastructure investments.

Despite concern of a possible 30 percent decrease in FY 2019 funding relative to the 2017 actual budget, the Office of Management and Budget (OMB) directed NSF to prepare a budget for close to the amount received in 2017. There are minor decreases across the directorates to reflect spending for NSF's Big Ideas. GEO received 3.3 percent extra funding for 2019, but the foundation moves money between directorates to account for other obligations and the actual number will accord with what other directorates received relative to FY 2017. There is a 14.3 percent increase for The Office of Polar Programs (OPP), representing the first installment for The Antarctic Infrastructure Modernization for Science (AIMS).

Dr. Easterling reviewed the origins of NSF's 10 Big Ideas and said there is funding in the FY 2018 budget to launch some of them, with the real work beginning in 2019. He focused on two, Navigating the New Arctic (NNA) and Convergent Research.

He briefly reviewed the importance of the Arctic and said NSF's FY 2019 request is for \$30 million, which will be available across the directorates to support:

- Development of a robust, integrated pan-Arctic observational network.
- Research to foster a comprehensive understanding and modeling of natural and human activities.
- Partnering with State and local governments, indigenous peoples, and international organizations.

A Dear Colleague Letter (DCL) was issued in February.

Turning to Convergent Research, Dr. Easterling said interdisciplinary Earth Sciences research often does not blend disciplines effectively without a fully integrated and interactive model. The right disciplines have to be at the table at the outset and the right models have to be designed in a synthetic way from the ground up. Using Innovations at the Nexus of Food, Energy, and Water Systems (INFEWS) as an example, he discussed red flags regarding food production, the rapid increase in projected global energy consumption, and the large demand this will create for water. It is an area ripe for Convergence Science. He noted the FY 2019 request for Food, Energy and

Water (FEW) systems research is \$16.4 million, with additional funding from the U.S. Department of Agriculture (USDA). A solicitation was issued in March.

Regarding sexual harassment, Dr. Easterling said NSF is taking a serious approach to how it responds to incidents. According to a February notice, “The National Science Foundation (NSF) does not tolerate sexual harassment, or any kind of harassment, within the agency, at grantee organizations, field sites, or anywhere NSF-funded science and education are conducted.” He is on a panel advising the NSF on a new and much stricter policy on dealing with harassment and Dr. Falkner has been leading a committee drafting a new policy statement.

Returning to FY 2019 budget request, he said launching the Big Ideas requires shifting resources, leading to a decrease in Atmospheric and Geospace Sciences (AGS) and Earth Sciences (EAR). Ocean Sciences (OCE) has a 7.2 percent increase, but normalizing for money temporarily removed earlier, it would show about a 5 percent decrease compared with FY 17. The Integrative and Collaborative Education and Research (ICER) shows a 37.4 percent increase, reflecting funding for NNA that can be spent by other directorates.

Dr. Easterling briefly reviewed research by Dr. Nigam showing the Sahara growing nitrogen in the Earth’s bedrock, Dr. Pomponi’s research showing that deep-sea coral ecosystems may help cure cancer, and Dr. Paul Falkowski’s receipt of the Tyler Prize.

Turning to NSF’s response to natural disasters, Dr. Easterling noted:

- Nearly 60 awards have been made totaling \$5.3 million in response to recent hurricanes.
- Rapid Response Research (RAPID) grant: Effects of Hurricane Harvey’s extraordinary rain event on sedimentation at tidal inlets of Galveston Bay, TX.

These awards are consistent with NSF’s commitment to Risk & Resilience as a major investment area. The FY 2019 request for Prediction of and Resilience Against Extreme Events (PREEVENTS) is about \$17.25 million in the GEO divisions and \$500,000 in the Office of Polar Programs (OPP). He said this work:

- Enhances understanding of natural processes underlying geohazards and extreme events.
- Improves the capability to model and forecast such hazards and events.
- Reduces the impact of extreme events on life, society, and economy.
- Improves prediction and warning systems that will support mission agencies, such as the National Oceanic and Atmospheric Administration (NOAA), the Department of Homeland Security (DHS), and the United States Geological Survey (USGS).

An emerging GEO interest is coastlines and people. By the middle of the century, almost 75 percent of the world’s population will live within 100 kilometers of a coastline, putting them at risk for flooding, sea-level rise, storm surge, trans-ocean subduction and tsunamis. The science is ready for understanding these risks and NSF is getting positive encouragement from the Hill and other agencies to participate in a major effort.

He turned next to augmenting *Dynamic Earth: GEO Imperatives & Frontiers 2015-2020* (DE) to keep it relevant. The AC will consider creating an addendum to the report.

Discussion:

Dr. Hodges said the AC meeting would later look at the FY 2019 request in the context of what was in DE regarding the difference between imperatives and frontiers. Dr. Easterling said frontiers eventually are given strong consideration for becoming imperatives.

Update on Convergent Accelerators

Dr. Dawn Tilbury, Assistant Director for Engineering (ENG), discussed convergent accelerators (CA), or accelerating convergence research, for two of NSF's Big Ideas: harnessing the data revolution and the future of work at the human-technology frontier. Multi-disciplinary teams will be focused on specific outcomes. Cohorts of teams will work as a network to encourage collaboration. There will be a range of approaches with multiple teams. CAs differ from foundational research in that they have intentional outcomes that are more goal oriented. CAs also feed on the tension between top-down direction setting and bottom-up creative approaches.

Unlike private accelerators that target start-up formation, NSF wants to accelerate the process of convergent research. NSF is directed toward solutions, but not specific markets. NSF is directed towards outcomes that take advantage of a unique skill set that can be delivered by the people with whom it engages.

Dr. Tilbury highlighted a few of the 14 qualities of CAs. They include an immersive educational component and a substantial mentorship program including peer mentorship. The CAs are expected to attract corporate partners, with about half of the funding coming from outside NSF. The CAs are limited to 5 years and can be renewed for another 5. Teams, which have high-risk but feasible targets and are measured periodically, can adapt along the way.

An example of a problem that a CA might approach is harnessing the data revolution. She said the accelerator might develop an advanced science data infrastructure that is interoperable and has an open architecture or develop an open knowledge network.

For the human technology frontier, one example could be a smart factory and office. This could involve accelerating and improving thought and judgment for decision making and problem solving jointly with technology. She suggested:

- Physical and cognitive monitoring systems that capture actions and decisions in real time to continuously collect data.
- Systems analyze and advise the optimal task distribution and coordination between worker and machine.
- Future jobs are fusion jobs and human and machine work is more engaging, fulfilling, and meaningful.

The phases for CAs start with input that includes basic research results that have been generated with NSF principal investigators (PI) and partners from industry and government helping form the team. Teams can be seeded organically through structured workshops and are multi-disciplinary and diverse. Once seeded, teams write short proposals to become an official CA team. In the team formation stage, there might be approximately 20 teams in three to five tracks. They would spend a week at a site going through intense education on relevant subject matter and on team dynamics. At their home institutions they would continue research for 6 months

working toward their goal. During that time, mentors or facilitators would meet with the team via conference calls at least once a week. After 6 months the teams meet again to make a pitch for how far they've progressed and to describe their next steps. Teams would be selected for grants to do accelerated research (\$1-2 million per year). The teams would be monitored monthly to keep the research accelerating toward the goal. At the end of a set period, there would be a competition for a prize.

Convergent Accelerators build on NSF innovations and best practices:

- Network model: The NSF Innovation Corps (I-Corps) (Nodes, Teams and Cohorts).
- Collective Impact: NSF Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES).
- Team Development: Ideas Labs.
- Industry-inspired Workshop on Quantum (Mar. 2018): Industry wants more similar workshops on Harnessing the Data Revolution (HDR) and the Future of Work at the Human - Technology Frontier (FW-HTF) topics (and Understanding the Rules of Life (URoL)).

Convergent Accelerators add new dimensions:

- Selection by pitch, instead of 15-page research proposal.
- Competition for monetary prizes.

Discussion:

In response to a question from Dr. Hodges, Dr. Tilbury said mentors are chosen from a known group with skills in team dynamics, formation, and facilitation. There will be a suite of mentors for a cohort of teams. It will be a challenge bringing that network of mentors together.

Dr. Hodges also asked who judges the pitches. Dr. Tilbury said there might be a panel of merit reviewers attending the pitch. They will also take input from the NSF Program Officer (PO) or other mentors who followed the teams, which will provide detailed information about the team's work. There may also be input from other teams in the cohort.

Dr. Lynch asked about the possible conflicts of sharing with industry, including reporting and open data standards. Dr. Tilbury said CAs would use a mechanism like that used in the Industry – University Cooperative Research Centers (IUCRC) program. NSF gives the core money for the basic research and industry contributes, with an average 7:1 match (non-NSF to NSF). The membership agreement specifies how intellectual property (IP) is handled using non-exclusive royalty-free licensing.

Dr. Pomponi asked if there are GEO topics that can be used as part of the CA approach and if there is funding for it. Dr. Easterling responded that the CA approach is designed for research domains with more market ready kinds of knowledge. But, he suggested there could be a type of interdisciplinary project to produce a better model for teleconnections between the loss of Arctic ice cover and weather in the Northern Hemisphere using a team to answer that question. Whether or not it leads directly to a large amount of market potential, it would involve industry input. Dr. Pomponi said she liked CA because it combines top down and bottom up and is a directed approach to a multidisciplinary question.

Dr. Hodges emphasized the basic science component and said the National Aeronautics and Space Administration (NASA) is doing this work at virtual institutes.

Dr. Tilbury said the two Big Ideas chosen for CAs would attract industry partners or other government partners. If the approach works, it will involve a lot of work, but is worth trying.

Dr. Van Dover suggested PIs might want to adopt pieces of CA for their interdisciplinary work through core programs.

Dr. Tilbury responded to a question from Dr. Hakim by confirming that each individual team makes a pitch, so not all teams in a cohort would get the accelerated research grant. There would be a small amount of funding for team formation. Dr. Hakim said the best teams take time to develop effective relationships so the accelerated timeline preferences existing teams. Dr. Tilbury agreed but said those teams might not have all the needed expertise and could add more members from among those met at the workshop. Also, teams that aren't funded might keep working together to make another pitch.

Report on the April Meeting of the Advisory Committee for the Office of Polar Programs

Dr. Falkner said last week's AC-OPP discussed harassment and the progress NSF is making. The AC also discussed PLR strategic planning, which will pull together priorities that have already been expressed. There was also discussion of NNA, including a joint session with the Engineering Directorate. That included breakout groups and a talk from Dr. Matthew Jull, Assistant Professor of Architecture at the University of Virginia, who is Director of the Arctic Design Group, which sparked conversation on how to deal with the built environment and changes being seen in the Arctic. AC-OPP also met with the Advisory Committee for Environmental Research and Education (AC-ERE) to discuss overlapping interests. Dr. Falkner said AC-OPP was happy to see the president's budget includes money to address NNA objectives.

Discussion:

Dr. Falkner added that nine AC-OPP members, who transitioned from an AC-GEO subcommittee, will be reaching the end of their terms; a new chair will be announced soon. She also said AC-OPP was excited about move out on AIMS, which is included in the president's budget.

General Discussion of Public Comments Received and Gaps Identified in *Dynamic Earth* (2014)

Dr. Hodges began with the background and purpose of *Dynamic Earth*, saying that GEO established an activity of periodic strategic planning exercises for the directorate. An important part of that process is the development of an advisory document by AC/GEO to provide an external perspective regarding focus areas for NSF investment in the geosciences. The document cannot be prescriptive. He said it is an AC document requested by NSF GEO. The committee can write from the members' perspective, which may not necessarily mesh with the GEO perspective.

DE was developed over several years and released in 2015. It was created to serve as a strategic planning document for the five-year period 2015-2020. It builds on and is consistent with three prior documents:

- *NSF Geosciences Beyond 2000: Understanding and Predicting Earth's Environment and Habitability* (1999).
- *GEO Vision: Unraveling Earth's Complexities Through the Geosciences* (2009).
- *Recommendations for Polar Programs* (2013).

DE also builds on several strategic planning exercises within GEO, Community exercises supported by GEO, and ad hoc community input between 2009 and 2015.

The motivation for updating DE is that AC-GEO intended DE to be a “living document” that would be reviewed and either updated, revised, or rewritten by AC-GEO episodically over the 5-year period. Additional strategic planning exercises, largely program specific, have been undertaken since 2015 or are on-going foundation-level initiatives that provide special opportunities.

DE's key elements include four thematic areas:

- Research.
- Community Resources and Infrastructure.
- Data and Cyberinfrastructure.
- Education and Diversity.

These areas reflect established directorate-level imperatives for 2015-2020. Dr. Hodges emphasized that the thematic areas were already established by GEO.

The research imperatives are:

- Continue a strong emphasis on and support for core research.
- Establish a collaborative effort to improve understanding of, and resilience to, hazards and extreme natural events.
- Establish a collaborative effort to understand the water cycle.

The community resources and infrastructure imperatives were:

- Maintain state-of-the-art facilities.
- Complete construction and begin full-scale operation of the Ocean Observatories Initiative (OOI).
- Implement strategic plans for logistics and operations for the polar regions.
- Begin conceptualization and development of next-generation sun-earth-system community models.

Data and Cyber Infrastructure:

- Develop community-driven cyberinfrastructure to advance data/ model-enabled science and education.
- Harness the power of computing and computational infrastructure.

- Invest in infrastructure for observing systems and sensor arrays.
- Use distributed instrumentation and facilities in support of research and education.

The education and diversity imperatives were:

- Increase undergraduate exposure to and enrollment in the geosciences.
- Prepare a capable geosciences workforce.
- Broaden participation of underrepresented groups.
- Promote public and community-based science to improve public STEM literacy and decision-making and to advance the geosciences.
- Promote the use of community resources for both research and educational purposes.

Dr. Hodges noted the lack of research imperatives in DE before listing the research frontiers:

- Emerging frontier opportunities that GEO should support should funding become available.
- These Research Frontiers reflect loci of growing interest and activity among GEO researchers that span multiple GEO divisions.
- GEO will support Frontiers in the interest of advancing scientific knowledge but will not do so at the expense of core research. Supporting fundamental research is GEO's number one priority.

The last point, he said, is a core message. Frontiers are a collaborative effort, coming from:

- Core research supported in AGS, OPP, OCE, and EAR.
- The research community (including national studies and national meetings)
- GEO program officers.
- National priorities (e.g., White House, Office of Science and Technology Policy (OSTP), OMB).

Frontiers require an infusion of additional resources to be supported. The research frontiers described in DE were developed from many sources, with input from GEO program officers based on their interactions with the research community and their PIs. Other sources include national priorities outlined by OSTP and OMB.

DE identified these research frontiers:

- Earth Systems Processes that cross the land/ocean interface.
- High latitude ocean-atmosphere-ice ecosystem interactions and processes.
- Urban geosystem science.
- Early Earth.

Community input supported including in any revised, amended, or rewritten version:

- Highlights from the U.S. Continental Scientific Drilling and Coring Community Science Plan.
- Mention of the importance of studying the geological origins of biodiversity (“geogenomics”).
- Mention of the importance of critical zone science.
- Mention of the importance of studying the evolution of large lakes.

- Increased emphasis on all oceans, not just circumpolar.
- Increased emphasis on energy and the environment.
- Mention of the importance of geoscience education research.
- Increased emphasis on education and outreach.
- The need for structures for interdisciplinary proposal review.
- Mention of the Southern Ocean Carbon and Climate Observations and Modeling project.
- Increased emphasis on groundwater.
- Increased use of specific examples (e.g., water issues in Flint, Michigan).
- Increased emphasis on atmospheric research.
- Increased emphasis on earth-surface studies.
- Increased emphasis on Ocean Observing Initiative.
- More focus on the importance of core programs and curiosity-driven science.
- More focus on early Earth.
- More focus on the value of Earth observational data.
- Increased emphasis on cross-NSF initiatives and on collaborations with other entities (NASA, USGS, the National Center for Atmospheric Research (NCAR), etc.).
- Increased emphasis on Geospace Sciences.

Dr. Hodges listed the following initial questions:

- Should we restructure, rewrite, revise, or amend?
- Should we include changes suggested by all correspondents?
- What's missing?

At the last AC/GEO meeting the general sense was to amend, but that should be revisited. He said there are ways to better get the message out, so it isn't missed by readers. Regarding the second point, he noted that the comments are inconsistent. Finally, there is clearly information that is missing.

Other questions include:

- How do we distinguish imperatives and frontiers?
- How much can we (as a committee) modify the imperatives?
- Should we include tactical suggestions for enabling strategic goals?

Dr. Hodges suggested rethinking the imperatives/frontiers wording. He also asked if AC/GEO has the right to modify imperatives set by GEO.

Moving to assignments, he said all members need to contribute and he proposed defining and categorizing proposed changes today and tomorrow. By the end of tomorrow, working groups need to be defined for specific categories, with a specific lead for each. And everyone on the AC must be on one of the working groups. He proposed a schedule by which all working groups must have extended drafts of their sections finished by the next AC/GEO meeting, following which Dr. Hodges will write a first draft of the final document.

Discussion:

Dr. Lynch suggested the document was too long and said strategic guidance should be focused on the critical messages. Dr. Hodges said there is a problem with including anything specific, which opens it to criticism of what is omitted.

In response to a question from Dr. Van Dover about DE's primary audience and how it is used, Dr. Easterling said anyone in the community seeking general guidance on placing their research in the context of what groups like AC/GEO think is important. Also, the National Science Board (NSB) asks NSF how the directorate's large facility investments enable its strategic priorities. DE is one way that is used to inform the board.

Dr. Constable asked if there are examples of DE not supporting what NSF wants to do. Dr. Easterling said he has not been with NSF long enough to see any such examples. Dr. Shepson said program directors (PD) who implement the priorities in DE look to the document. If a proposal reviews well, is consistent with the agency's mission, is recommended for funding, but is not mentioned in DE, it would be funded. DE is broad guidance to PDs.

Dr. Lisa Clough, OCE Section Head, said DE has been a good partner with the report, *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*. DE is permissive enough to pair with other division-specific priority documents. She knew of no situations where funding was denied because of DE. It is important to keep in mind where DE fits with other division documents and NSF's overall strategic planning.

Dr. Patino, speaking for EAR, agreed, adding that DE is useful in partnership with other documents received from the community and EAR commissions. It does not tie EAR's hands. EAR ultimately responds to the community at large.

Dr. Semeter referenced the recommendation about the geospace section activities, which came from The American Geophysical Union's (AGU) Advocacy and Policy Committee, including six luminaries of the geospace field. Their request grows out of formal recognition by Federal agencies that space weather is part of national security. It has become a less esoteric area and more central to understanding how to proceed as a society. Something succinct should be included about the Space Weather Action Plan.

Dr. Hodges said there should be something explicit about this and other things, but the imperatives/frontiers narrative is constraining. DE implies the number one item for funding is the core programs. If the core programs are cut, then fewer frontiers, or none, should follow.

Dr. Hakim asked how DE was used to develop NSF's Big Ideas and how it will be used to implement the Big Ideas. If it is to be used for the latter, DE should be reoriented. Dr. Easterling said all the assistant directors along with the director and her leadership team knew they wanted to identify some big science initiatives across a range of disciplines where the science could be pushed forward in a nonlinear fashion. His predecessor took guidance from DE in forming the essential questions that make up NNA. DE played a role in suggesting at least one of the Big Ideas, which is assigned to GEO to develop. Many of the big challenges in the Arctic have to do with making sense of the large volume of data from all the platforms that could be established, in addition to those already there. This is a prime example in the broader effort to study big data.

Often when those from Computer and Information Science and Engineering (CISE) talk about the data revolution, they use Earth science examples, for example mobilizing data to track a tornado in real time to forecast direction.

Note: The following bracketed discussion could not be heard by meeting attendees located at NSF:

[Dr. Lynch asked if DE needs to be revised and if other directorates have AC-generated plans. PDs know what they are doing and have a vision. Dr. Hodges said it is hard to be enthusiastic about adding to DE if it is treated as just another document. Dr. Constable said the broader community does not see DE as driving what they are doing or how it will change their science. If something is not in the document, it is saying it cannot be done. Dr. Pomponi said commenters missed the point that core support was the most important. There was a sensitivity that big programs are squashing single initiatives. Dr. Hodges said including something from every comment would spark more dissatisfaction. Dr. Constable said that when DE was first published, it was not seen by researchers as relevant to what they do. In spite of assurances that core science is a priority, people do not think they're experiencing that.]

When two or three imperatives are highlighted, Dr. Constable added, readers think that's where the money will go. Dr. Hodges asked if a document is needed. If it is, it should include the kinds of science GEO should support, without naming specific investigations.

Dr. Lynch said that during the discussion that attendees at NSF could not hear, a decision was made to update the report.

Dr. Easterling pushed back on that decision. In any science field, the ability to hold the attention of the research community, the public and Congress, requires stating the exciting research questions that have never been fully formed or answered properly and articulating why advances in those areas are so important that we should invest in them. If we're satisfied that questions in DE are still the drivers for discourse over the funding decisions, then no changes are needed. But we are at a point where there are some questions that have arisen that are a little better focused today than 5 years ago. For example, coastlines and people. There isn't a single scientific question from the geophysical point of view in coastlines and people that has not been posed before. But they have never been put together with a realization that geophysical processes are happening in highly populated coastal areas and bring people in contact with risky situations. With better knowledge of how these processes work, better information could be provided to policymakers, local officials and the community to manage their regional economies and community safety. He asked for a conversation about the driving questions that were not asked in DE.

Dr. Shepson said prominent members of Congress do not know what NSF does or why it is important. It is important that GEO has a strong publicly accessible document that articulates the important questions the community is pursuing and why it is important to the public.

Dr. Pomponi asked again about the intended audience. The document is valuable if it is updating the strategic imperatives, checking off things that have been done in the last 5 years, and stating

where GEO is now. That is different from a hit list of projects that the scientific community will see as a top down approach. There needs to be an update of DE because in 2020 the reaction will be, Now what? It is part of AC/GEO's responsibility to make recommendations to GEO about future directions for the next several years. But we need to consider the audience and make sure the new document addresses the issues important to potential sponsors.

Dr. Constable urged writing a shorter document. Dr. Paola added that half the comments are about the responder's area not being represented. That type of comment is common with these surveys and needs to be filtered out. Nobody should be setting the primary research targets. If writing for funders, it might say what kinds of things are done in a program with examples of successful research where funding would make a difference in people's lives. He asked if Congress really wants to know the 5-year priorities, or just get a sense that NSF is paying attention to what people need.

Dr. Easterling said he didn't mean to say Congress and its instrumental values should drive the entire conversation. Many members of Congress appreciate that science must operate unfettered from expectations and that findings will immediately have real world value. If the story explains why a fundamental part of the discipline is to advance the science, that will be accepted as important and in need of funding. For example, the report does not have to be focused on risk and resilience. It can also be more creative and articulate about what we do when pursuing curiosity-driven research and why it is important and deserving of support.

Dr. Hodges said the problem is trying to write one document for every use. He asked if the document is to be outward looking or an internal perspective on GEO focus areas.

Dr. Easterling said the geosciences research community uses DE for general guidance for where their science fits. There are large areas of our disciplines that are not visible. It also provides a level of guidance thematically for what NSF is thinking and how to frame the next generation of questions to be asked in the Earth sciences. So, the document needs to be flexible and able to refocus on specific questions. It also needs to be generalized enough to pivot to specific opportunities as they come up. With the emerging importance of geospace science there is very strong interest in the operations areas of NASA and NOAA. But there is mention of emerging geospace issues in the current version of DE. He asked if that is an area that should be put in as an addendum.

Dr. Van Dover said that as a community member she feels totally disenfranchised reading DE, does not feel appreciated and does not feel it was written for her. She discussed the distinct roles geoscience and NSF plays in society in terms of generating knowledge and responding to societal needs. She suggested thinking about the bigger categories and having examples of things that are critical to society but are currently not being advanced.

Dr. Kempton agreed with Dr. Hodges. Three purposes for the document have been discussed: 1) outward facing stakeholders; 2) guidance to GEO on emerging research priorities; 3) research to support societal needs. No one document can hit all three. Also, the community does not feel DE speaks to them. The discussion is not coming to grips with understanding the document's audience.

Dr. Borg said multiple documents might be advisable. But from NSF's perspective, if there is a document that we are using to guide what we do, it is important for transparency to share it; it must be understood by the outside community. Therefore, it must serve at least two functions: guiding NSF and a document for the community that they can support. It is a different question whether it is a document to highlight geosciences research contributions for Congress.

Dr. Kempton agreed and said it may be possible to hit those two targets of emerging priorities and speaking to the community. That would be more feasible than also reaching congressional stakeholders and those who benefit from the research.

Dr. Easterling agreed. He stressed being transparent about how NSF thinks about its funding priorities and conveys that clearly to the research community. There is also a need to be transparent about our questions and objectives with the NSB, which pays attention to such documents.

Dr. Lynch said DE is not that document; it excludes rather than includes. She suggested a shorter document that draws from DE but would be broader and more strategic.

Dr. Semeter said the small number of responses is not an indictment of the interest in DE. The responses are single-author or two-author e-mails. But the geospace response came from eight authors representing AGU leadership and it isn't clear why others didn't take this tact. Also, it can't be known which of these documents will gain traction. Some emerge in congressional hands years later.

Dr. Kempton said she didn't necessarily agree with Dr. Semeter's point about response. She said about 20 percent of responses were from groups. The number of responses indicates either that the community is happy with DE or they don't see themselves at all in it. Dr. Semeter said it may not mean either. In any case, the committee must do its best to put together the best product.

Dr. Kempton said she's hearing there is some need to update or amend DE with guidance to GEO and to make it clear to the community where they fit. There is a need to update and refresh DE to show where there are things that have happened and where the next things are emerging.

Dr. Easterling said he has given a dozen talks about GEO to various groups of geoscientists, where he mentions AC/GEO's interest in writing an addendum to DE. When he asks how many are aware of DE, 20 percent at most respond. It is one of the best kept secrets in NSF GEO. The document needs to be made more accessible to the geosciences community.

Dr. Hodges summarized the discussion as concluding the document needs more than an addendum. Also, there may be too much detail in DE and not enough generalization. Space weather is mentioned on Page 16 under areas of community resources and infrastructure. It includes an imperative to begin conceptualization and development of next generation Sun-Earth systems community models. Because it has been pushed into the concept of modeling it almost sounds like we're going to support the development of improved modeling techniques to handle a multi-scale phenomenon. When people see a focus on modeling not observation, they lose

enthusiasm. Being more general in the focus areas increases the probability your constituents who are funded researchers will find a place in the document. So, it should be shorter and less specific.

Dr. Constable agreed that there needs to be less detail and more about what would enable the detail. Dr. Semeter agreed the geospace representation is buried and if mentioned in the context of a larger cohesive DE mission, it could be more prominent and support a shorter document. He said that would involve a major rework, which Dr. Hodges said is not outside the committee's purview.

Dr. Easterling said the discussion reminded him of how the academy likes to do grant challenge assessments where they work together as a panel and write a series of questions that should drive the science forward 5 years. Under the challenges one could list more specific implied areas of research to push the science forward to give a better understanding of the challenges. On the surface of it, that could be a useful document for the foundation.

Dr. Pomponi said this approach would require soliciting input from the broader community. She said the document doesn't speak to her. It is going to require broader input on the grand challenges but the committee is not set up to do that. She fears there would be a small list of grand challenges and specific areas that again will elicit responses of not being included. If the grand challenges in GEO are not speaking to a broad swath of the community, we need to revisit how the committee is coming up with them.

Dr. Paola expressed skepticism about shaping research with such documents. He asked if they are used inside the Foundation to fight for funds. Dr. Murray responded that Dr. Paola identified an important audience. They are seen as the voice of AC/GEO and are used internally.

Dr. Easterling recounted meetings with the director and assistant directors and the excitement over the detection of gravity waves. The director will, in effect, ask the assistant directors for their version of gravity waves. He responds by talking about subduction zones and predicting earthquakes and the impact of the warming in the poles. The director is where a lot of initial funding decisions start. For the document, Dr. Easterling said he was not invested in grand challenges, the committee can empower him and rest of directorate when bargaining inside the foundation for resources.

Dr. Hakim agreed that GEO needs to clearly and convincingly make its case to funders. The document positions GEO in NSF and provides the tools the director needs to make the case at a higher level. It does not need to speak to individual members of the community.

Dr. Shepson said it is important that NSF serve the needs of the scientific community and enable the best science that advances our understanding of the Earth. A strategic plan should get all of us to think deeply about how we want the science to serve society. It is partly a vision document and should be high level. If it speaks to everyone it will not be interesting. It needs to express the importance and impact and high-level priorities for the community we serve. Half the value is having the conversation with the community about what we want to achieve. He did not mean to

say earlier the main audience is Congress. We can always do a better job articulating return on investment.

Dr. Hakim said that using it to argue for funding is an effective use of the document. He agreed with Dr. Paola that the document is not used by researchers to shape what work they do. The document is so the director gets excited and has something to use when talking to Congress.

Dr. Constable said the document needs some ideas about things of great practical use in addressing hazards and resilience. Astronomers and astrophysicists appeal to people based on fascinating discoveries whereas GEO says it is providing protection by increasing knowledge of hazards and risks, rather than selling the science as exciting in its own right. She urged a balance between the practical and creative.

Dr. Hodges said he heard opinions changing during the discussion. He proposed writing a new document, rather than amending DE, which he said lost its way. It is trying to do too many things. The audience is the director and the document should say how and why NSF should spend its resources in geosciences. A compelling argument can be made with a few specific examples. He described GEO as the dominant funder of the science of human survival, a powerful justification for GEO. He suggested talking specifically about things that are high level. One of the hottest topics is exoplanet research, which is directly traceable to Earth systems. The document can make a profound argument that this is why GEO is important. He would also include how geoscience is done, adding that it invented interdisciplinary research. The idea of how geoscience is done and takes advantage of growing and new directions is a great story to tell. DE was not meant to do that.

Dr. Paola agreed but suggested writing three short documents for different audiences. One for fellow scientists in different fields to provide intellectual excitement; one for Congress and the public; and one for colleagues. After they are written, they might be able to be merged.

Dr. Constable said intellectual excitement should be conveyed in the version for Congress.

Dr. Hodges asked if anyone supports amending DE. Dr. Hakim said if the cost in terms of time commitment of a separate document is going to be high and the utility low, then he supports amending DE. Dr. Hodges said if it is a foundational document that is used aggressively, it is worth the cost. If DE works well for its intended purpose, there may be no point.

Dr. Hakim said the Big Ideas is the elephant in the room and spoke of advising GEO in a way that positions the community well to pursue those opportunities. To whatever extent the document informs on that, it needs to be taken seriously.

Dr. Easterling said a pithy, eye-catching document at the right level of generality that gives him the tools to make strong arguments for the resources needed in the directorate to do science across a broad swath of the geosciences is very helpful to him internally and for GEO program officers. When we have a major set of questions the Foundation's leadership sees as important, there are bigger investments across the board. Dr. Borg agreed.

Dr. Pomponi said the AC is being asked to provide advice to Dr. Easterling. She asked him whether a DE addendum or a free-standing document would be more useful. She suggested working with division directors to formulate a plan to carry it out. Dr. Easterling said he supported a stand-alone document on the new directions for Earth sciences.

Dr. Murray agreed with Dr. Easterling on decoupling the new document from DE. The new document should not replace DE. He suggested the new document be 5-10 pages that is framed around Dr. Hodges' earlier reference to GEO as the science of human survival. He also supported involving the division directors.

Dr. Lynch said a short document will serve a revitalized purpose and give Dr. Easterling the ammunition he needs. Dr. Semeter also agreed. He said it was infuriating to be asked for GEO's version of gravitational wave detection. What is the cosmologist's version of species survival? If humans have no future on the planet, there is no sense in detecting gravitational waves. He suggested beginning the document with a doomsday question. Geosciences is about understanding the habitable environment and there is nothing more important. Dr. Borg said he preferred understanding the habitable environment more than the survival theme.

Dr. Murray said he supported anchoring it around a wholistic concept involving humanity. He supported Dr. Semeter's phrasing about nothing matters without human survival. That is worth tapping in a positive way.

Dr. Easterling underlined the positive outlook. One of the criticisms leveled at the Earth sciences is that they are doomsayers with never a good word to say about the future. But he advocated calling a spade a spade. This needs to be done with a scalpel, not a sledgehammer.

Dr. Hodges said there are many ways to do it without being negative. The question is how to ensure survivability of our species and others, which creates a positive spin. We are coevolving with the planet and without understanding those processes, we cannot go far in understanding survivability. He said the document should be short, sweet, and useful.

Dr. Easterling suggesting recapping the foregoing discussion when the AC meets with the director. Dr. Pomponi suggested also bringing it up during AC's meetings with division directors.

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. France Córdova to AC/GEO.

Dr. Córdova said the Foundation is committed to the geosciences and its institutions. She thanked the committee for its advice and welcomed new members. She noted NSF's new strategic plan, *Building the Future: Investing in Discovery and Innovation*. Its' goals are: expanding knowledge in science, engineering, and learning; advancing the capability of the Nation to current and future challenges; enhancing NSF's performance of its mission. Dr.

Córdova also discussed ending sexual harassment and thanked everyone for their engagement in the issue. She said Dr. Borg has been appointed as permanent GEO Deputy Assistant Director and thanked those leaving, Dr. Shepson, Dr. Frost, and Dr. Murray. She mentioned a White House event in connection with Ocean Month, as well as a meeting with NOAA officials. She also mentioned the 10 Big Ideas and a February Dear Colleague Letter (DCL). She will be attending an Arctic science ministerial in October. She concluded by noting that Dr. Joan Ferrini-Mundy, Chief Operating Officer, is leaving to become president of the University of Maine.

Discussion:

Dr. Hodges reviewed the committee's DE discussion. He noted that AC/GEO decided to write a new document that emphasizes the value of geosciences to NSF and society. Dr. Borg added that DE still has value and will not be withdrawn. The new document will address what is missing in DE. Dr. Easterling said it will also empower him and the director with examples of the kinds of questions important to the science that demonstrate clear value in the research and can be used by NSF and anyone else with a stake in supporting NSF.

Dr. Pomponi asked about opportunities for convergence accelerators (CA) in the geosciences. Dr. Córdova said CAs are intentional and focused, driven towards deliverables on a shorter time scale. Because of budget uncertainty, the DCL was missing an intentional-focused, accelerated path to delivering something. In the NNA theme, one can envision measurement sensors that are cheap and fast to build using techniques of autonomous vehicles and drones in the atmosphere and under the sea, towers that are cheap to erect with 3D printed sensors, with more well-sampled measurements across the Arctic. The big challenge is the database and issues of how data are collected, accessed and distributed.

Dr. Pomponi emphasized the embrace of both top-down and bottom-up approaches that are targeted, directed, and goal oriented. The new AC/GEO report might consider some of the ideas in geosciences that might benefit from a CA approach.

Dr. Paola asked about how reports like DE are used at NSF. Dr. Córdova said decadal reports from the National Academies are well respected by Congress and have much influence. She mentioned the National Academies *Sea Change* report, which helped geosciences rethink its balance between individual investigator-funded programs and big facilities, which affected requests for numbers of research vessels and calls for operating facilities. These reports are an independent voice and have a special place in attracting the attention of Congress. AC/GEO's voice is as important but not as independent since NSF selects the members. There are not decadal-type reports and Academy reports in every subject. (An NAS study in Earth Sciences will begin soon). AC/GEO fills an important niche for what the program portfolio could look like, ideas to think about, and goals and activities. To the extent reports are taken up by the greater scientific community, they can be very influential. They are important for planning what the program portfolio is going to look like and how it is going to operate.

Dr. Easterling added a report to the leadership of the Foundation gives the director and NSB reassurance that the funded research, and the directions embarked on, have a solid foundation in advice received from AC/GEO.

Dr. Córdoba said the Committee on Equal Opportunities in Science and Engineering (CEOSE) wrote a report that provided the foundation for INCLUDES. She also mentioned influential environmental community reports. Dr. Ferrini-Mundy recalled when the AC for Education and Human Resources (EHR) produced an incredible guide for the directorate's leadership and program staff. It was used to inform programs, change emphases, and make differences for how the work of the directorate was represented. It is still used 8 or 9 years later with budget presentations and directorate publicity. Dr. Easterling asked how much detail is needed to be effective. Dr. Ferrini-Mundy said the EHR report was 15-20 pages and the most important element was the framing it. The resulting document provided for three pillars of activity and was not comprehensive.

ACTION ITEM

Melissa will distribute report by the Advisory Committee for Education and Human Resources, *Strategic Re-envisioning for the Education and Human Resources Directorate*.

Dr. Kempton asked how high-level Big Ideas come about. Dr. Córdoba said NSF has invested in ideas that come to the agency, evaluating them through the merit review process. NSF does not often put out a group of Big Ideas as strategic initiatives for future investment. Though there have been NSF-wide investments, there had never been something with so many ideas. The Foundation felt on the defensive in response to negative things coming from Congress. A senior leadership retreat was used to think about positioning NSF to be forward looking and where it would invest if funds were available. The Assistant Directors and office heads gathered recommendations from their ACs and the National Academies and pitched those ideas resulting in "The 10 Big Ideas." The NSB fully supported all the ideas. In response to a question from Dr. Kempton, the director said the non-defensive approach is paying benefits. The Big Ideas are being put in the budget, which will make a large difference. They are electrifying the external community and it is the topic of conversation internationally. People are focusing on NSF as a visionary agency rather than a passively accepting agency.

Dr. Kraft, who teaches at a community college, asked how the general population perceives the NSF. Dr. Córdoba said they don't know the NSF exists. But the Foundation name is on some Public Broadcasting Service (PBS) shows and NSF is using social media extensively. NSF has not been getting out there like some other agencies though. All of that is changing, she said. Dr. Clough said she was impressed by how many members of the community came up with the change in harassment policy and said NSF's leadership got the agency's name out. Dr. Shepson said it was important to take credit for the impact of the fundamental developments NSF invests in, such as the ability to forecast the weather.

Dr. Córdoba said it is part of the AC's charge to, for example, invite members of Congress and staff to visit their campuses and see NSF-sponsored research. Press notices about discoveries should reference NSF.

Dr. Ferrini-Mundy said NSF had a major education initiative as a part of its science mission, which distinguishes it from other agencies. NSF works with its education colleagues to get the word out on what gets funded in that directorate. There is a very strong investment in community colleges through NSF's Advanced Technological Education Program and through curriculum in

undergraduate education programs. She referred Dr. Kraft to NSF's Community College Innovation Challenge aimed at getting teams of community college students to come together with innovative ideas.

Dr. Easterling said CAs are a test of the ability to move research and fundamental knowledge away from the bench. That begins to move the Foundation to being in plain view.

Dr. Kraft said the increased enthusiasm for community colleges is an opportunity to broaden the public's understanding of what NSF does.

Dr. Córdova said the administration puts a high priority on re-skilling the workforce. NSF's advanced technology program at community colleges has shown great benefits. Community colleges are generating economic growth and are generating more skilled jobs.

Dr. Hodges said that as deputy editor of *Science Advances* he was going to help show the link back to NSF funding, taking a cue from NASA. Dr. Córdova said NSF learned about taking the initiative for publicity by working with NASA on the Laser Interferometer Gravitational-Wave Observatory (LIGO).

In closing, Dr. Córdova said she was looking forward to AC-GEO's new report. She emphasized telling a coherent story with the questions you want answered. There is good support now in Congress and now is the time to go forward with a big vision.

Discussion Following Meeting with Dr. Córdova

Dr. Hakim summarized the director's guidance for the committee on its report. Dr. Hodges discussed the ideal length for the report, saying a shorter report would be more effective, providing a very high-level view. Dr. Easterling said 5-page reports tends to grow to 25 pages. It should be the right length to get the job done. But he also endorsed brevity.

The committee briefly discussed the director's comments on more aggressively promoting its work. Dr. Constable noted how NSF has been doing more in the last few years in this regard. Dr. Hodges agreed there has been a substantial change, with Dr. Borg adding that more funding is being provided for the effort.

Dr. Paola returned to the report, saying the director indicated they are writing it for their colleagues because it will affect how NSF allocates funding. This requires thought about community input.

Dr. Easterling distinguished between how NSF spends and acquires funding. The director's comments were directed more to the latter. He would like the document to generate what is called a willingness to pay and spoke about how the director sees the importance of the geosciences in terms of the best return on investment. Dr. Hodges distinguished how NSF invests and how GEO invests and said the director was discussing how money ought to be distributed to GEO. The document the committee is planning will speak more to that than, for example, what EAR will fund.

Meeting Adjourns for the Day

Thursday, April 26, 2018

Discussion of DE, Continued

Dr. Hodges said the committee decided yesterday that it would not amend DE but would write a new document that is short, hard-hitting, emphasizes the value of geosciences in the NSF enterprise, and argues for NSF investment in geosciences. It should also include ways to provide the most scientific impact through GEO. *Strategic Re-envisioning for the Education and Human Resources Directorate* is a good model for the new document. But it is not written for the director, but to the directorate with recommendations to improve the effectiveness of the funding process. That could be a partial model. The committee had also talked about exciting things in geosciences that would compel investment. The document should also include examples of cross-program projects.

Dr. Van Dover suggested a document that is geosciences oriented, not division oriented. Dr. Hodges agreed. Geoscience has an opportunity to work on crosscutting projects within geoscience. The linkages with the Big Ideas should be shown. Dr. Van Dover mentioned connections with genomics as an example.

Dr. Paola mentioned writing separately for Congress and other representatives of the general public, academic and colleagues about what's driving the science. Dr. Hodges distinguished who it is written for and who might read it. It might be useful for colleagues, but not targeted at them. The same applies to Congress. He said it did not have to target each constituency or be written as separate documents, as Dr. Paola suggested. Dr. Van Dover said there isn't the bandwidth to do three reports and asked about vetting with the community. Dr. Hodges said community vetting isn't needed.

Division Report Out: EAR

Dr. Constable reviewed the morning's subcommittee meeting, which covered a general update, cross-directorate engagement, and the impact of no-deadline proposals. She reviewed personnel changes, and recommendations for a table survey and an EAR day.

She said there was discussion of the FY 19 budget and how to manage a 5 percent cut while protecting core programs. Some programs are ending but there may be concerns for increased pressure on core programs. A decrease in Major Research Instrumentation (MRI) might be problematic for the community at large.

On cross-directorate engagement, they discussed two of the 10 Big Ideas, including Harnessing the Data Revolution (HDR). One concern was the money going to programming and development of cyber tools. There should be engagement from the geoscience side, she said. They also discussed Rules of Life and novel ways people are soliciting proposals. Signals in the Soil (SitS) was also discussed, which she said is an interesting cross-directorate program with ENG. Concepts are being looked at that may involve other agencies. They also discussed how ideas rise to the DCL level. She said it seems to work as a mechanism for providing new ideas into the NSF system.

On the impact of moving to no deadlines in the context of hydrology, a study found a more even distribution of proposals through the year, a decrease in the overall number, and increased success rates in proportion to the decreased number of proposals. The viewpoint of program directors is that the decrease is an advantage but workflow management, panel assignment, and conflict of interest require some adjustment.

Division Report Out: OCE

Dr. Van Dover reviewed the morning's subcommittee meeting, beginning with the search for Dr. Murray's successor. They also discussed the ongoing implementation of *Sea Change* and increasing infrastructure costs at the expense of core science. Infrastructure is at the target of 48-50 percent of the budget. This was through cuts that most heavily impacted the Ocean Observatories Initiative (OOI). There is a concerted effort to have OOI be used by the scientific community. The logistics infrastructure impact of cutting two of the seven ocean moorings was discussed. They also discussed the drilling program, which has had international subsidies and internal efficiencies, and the research fleet. The first of three regional class research vessels will come online in 2021. The global class vessels undergoing refits will produce a very capable but somewhat downsized fleet starting in the early 2020s. They also discussed the benefit to core science in technology and education.

Division Report Out: AGS

Dr. Shepson summarized two earlier meetings. The subcommittee reviewed mid-scale research infrastructure, NNA, harnessing the data revolution, convergence, and the Big Ideas overall. This will help with messaging with the AGS community to ensure full engagement in the Big Ideas. Today's meeting focused on the new document AC/GEO is planning. There was a consensus on making the case for investment in geosciences, so all the constituencies can understand and make sure geosciences gets the respect it deserves.

Dr. Semeter said the morning's discussion was on representing the geoscience discipline and AGS to the public, politicians, and their constituents. There is a realization of an existential threat to the geoscience directorate. He mentioned targeted cuts and said two branches of government are coming after the directorate's science. The way to help is better articulate what the directorate does. GEO, he said, has sometimes inconvenient conclusions that call for changes in how people live collectively, providing a special challenge. The new document should be succinct, support the director's vision and the Big Ideas, and be written to connect to Congress and constituents. The *GEO Vision* document was written in a more impactful style than DE, he said. The document needs to be blunt about GEO's societal relevance.

Dr. Heald presented the subcommittee's formulation of three items for describing the basis for geosciences:

1. Deciphering the fingerprint of planetary change (geological past, Arctic, Sun - Earth, etc.).
2. Understanding evolving global natural resources (air, water, soil, fuel, ecosystem services).
3. Predicting/forecasting natural disasters and global impacts (space weather, hurricanes, sea level rise, earthquakes, etc.)

Discussion:

Dr. Hodges said the three points provided a great start and asked about rephrasing the first item. Dr. Paola said he objects to a 100 percent reliance on societal usefulness. Some, he said, are driven by intellectual curiosity. Dr. Easterling said fundamental research priorities can be interwoven with the value priorities presented by Dr. Heald. Dr. Constable said intellectual curiosity could be a modification to the first item. Dr. Heald agreed that the first item was not intended to be limited to climate. Dr. Hodges agreed and suggested using the nature and tempo of planetary change. Dr. Shepson said a document speaking to the scientific community can present GEO's role in supporting curiosity-driven research in a mission statement. The three items presented address the director's question about GEO's compelling scientific challenges.

Dr. Shepson said the subcommittee discussed possibly finding a new way to refer to natural disasters to avoid a gloom and doom perception and focus on the positive services the geosciences provide society rather than being disaster focused. The subcommittee also discussed providing the director with three things that excite her about the geosciences that she can provide Congress.

Dr. Hodges said the discussion was about very short timescale events, e.g., sea level rise that happens quickly, hurricanes, and earthquakes. These have the most dramatic societal impact. The variable time scales used to look at processes help to understand and predict the impact.

ACTION ITEM

Dr. Heald's document will be distributed to AC/GEO and/or posted on the GEO website.

Finalize Outline for Updated Report

Dr. Kraft raised the distinction between how science is done and how it is communicated and conveying the issues' importance to a non-scientific public. Dr. Hodges recommended a fourth item: education at all levels and encouraging science communication and education for a more scientifically literate populace. Dr. Kraft asked about how best to do that, given that emotions shutdown logic. Dr. Van Dover suggested adding wording about next generation scientists. Dr. Hodges said geosciences education is a gateway to science education. Dr. Van Dover asked how the ocean sciences fits in, saying it can be included in all three items. Dr. Hodges agreed and asked about the definition of ecosystem services. Dr. Van Dover said it is definable and leads to the ecosystems' functions and structure. Dr. Pomponi said it was important to call out the role of biodiversity and resilience using top-level priorities to explain to funders and maintain credibility in the scientific community. Dr. Hodges agreed and said the text shoring up the bullet points is critical. Dr. Pomponi said the Big Ideas should not be emphasized to the exclusion of other ideas. There is a need to be specific. Dr. Hodges argued for a balance between specificity and generality. Dr. Paola raised the issue of long-distance connection and asked about a way of looking at planetary scale linkages. Dr. Easterling supported using the phrase long-distance connections. This could provide GEO's response to gravity waves. Dr. Hodges said scale and time is an important concept to include, including interactions with the Earth and other planetary systems.

Dr. Hodges said a plan is needed for how to approach the document and asked for reaction to Dr. Paola's suggestion for three documents that might be merged. Dr. Paola said he was thinking of a

page geared for academic peers, one for congressional staffers, and one for scientific drivers. He volunteered to work on the document.

Dr. Hodges said the committee needs to put words on paper, build an outline, distribute it to members, then ask for volunteers. Everyone is going to have to be involved. The work needs to be done before the next meeting. He asked for emails to the committee to be answered in a timely fashion.

Dr. Easterling said AC/GEO could write a good first draft of the document, and perhaps have a discussion of it, in 4 to 6 months.

ACTION ITEM

AC/GEO will complete an advanced draft of a new report by the next meeting, scheduled for October 17 – 18, 2018. Individual assignments will be arranged through email after the meeting.

Dr. Heald suggested, and Dr. Hodges agreed, that Program Managers should be engaged in the process. Dr. Hodges said they can help think about core cross-cutting ideas.

Dr. Easterling said NSF can provide guidance but cannot actively participate in writing the report. Dr. Shepson said Program Directors can answer questions about how the content might affect how programs are managed but must be independent.

Dr. Hodges said people in the trenches at NSF have a better sense of the community pressure about the Big Ideas than does AC/GEO or the National Academy. AC/GEO could use information about what is exciting from NSF's perspective.

Dr. Easterling said it would be legitimate under Federal Advisory Committee Act (FACA) rules to ask a Program Officer for a factual presentation of research priorities if it does not include recommendations for what to retain or not. The Foundation cannot make its own recommendations through the AC.

Dr. Paola asked if the three points Dr. Heald presented need to reflect the 10 Big Ideas. Dr. Easterling responded that basic research questions are contained in each of the Big Ideas and are implicit in Dr. Heald's three points. The questions the committee is formulating should find a hook in one of the Big Ideas, but these don't have to be directly referenced. He agreed with Dr. Hodges that this can be done subtly with sidebar examples.

Dr. Hodges said individual work on the report will be arranged through email. Dr. Easterling said arrangements can be made for working teams to meet in person.

Meeting Wrap-Up: Open Discussion and Action Items

Dr. Lynch asked about her role as an OPP representative and OPP's role in drafting the new report. Dr. Hodges and Dr. Easterling said the Polar component needs to be included. Dr. Hodges said Dr. Lynch played an excellent role on the committee and should raise topics of interest for discussion at committee meetings. In response to a question from Dr. Van Dover he said that input from AC-OPP representatives on AC/GEO was sufficient. Dr. Easterling said Polar

Programs needs to have a strong voice in developing the report and he will coordinate with Dr. Falkner; the two ACs do not need to meet jointly, at least for now.

Dr. Fuentes asked for an update on the search to fill Dr. Shepson's post. Dr. Easterling said there has been an active search since late last year for all three division director positions. For Earth Sciences and Ocean Sciences, there is an outstanding list of finalists. Offers for those positions will be made soon. The AGS was delayed and he has not yet seen the list of recommendations from NSF Human Resources that the selection committee will use. He praised the job being done by the acting division directors.

Dr. Easterling praised the committee for how much progress it has made in preparing for the new report, which he said will be very useful for NSF, and he wished them well.

Dr. Hodges thanked everyone and ended the meeting.