NATIONAL SCIENCE FOUNDATION (NSF)

Advisory Committee for Polar Programs (AC-OPP)
Spring Meeting, April 18-19, 2018
National Science Foundation Headquarters
2415 Eisenhower Avenue
Alexandria VA 22314

MINUTES

Action Items Arising out of the Spring 2018 AC-OPP Meeting

1. Dr. Manahan will lead a group of three to write the next version of the OPP strategy document; the other two members are Dr. Brachfeld and Dr. Weingartner. Mr. Arnaudo will provide wording about the Arctic Council and Dr. Dixon bullet items based on the *Arctic Horizons* report. Dr. Weingartner and Dr. Vieregg will also make contributions. Other AC-OPP members may also provide material. Dr. Backe will serve as point of contact for staff assistance. A near final document will circulate to AC-OPP by May 31 with a final document of approximately four pages ready by the Fall meeting.
2. Consideration at a future AC-OPP meeting of the Scientific Ice Expedition (SCICEX) program to determine the effectiveness of that partnership, as well as the feasibility of a submarine icebreaker.
3. The Fall AC-OPP agenda will include:
    - Discussion of whether some AC-OPP members will present the OPP strategy document at AGU.
    - The Subcommittee on the U.S. Antarctic Program's Research Vessel Procurement will present an update.
    - Mr. Kosseff and others will make a presentation on safety.
    - An update will be provided on the Thwaites Glacier and possibly MOSAIC.
    - The *Arctic Horizons* report will be provided to the committee.
    - A meeting with another advisory committee will be held, subject to schedule coordination.
    - How to assure the new generation of researchers has leadership qualities and is diverse, including indigenous Alaskans.
4. Dr. Backe will work with AC-OPP members to find an optimal time for the Fall meeting. (Update: The Fall 2018 AC-OPP meeting is scheduled for November 1-2, 2018.)

Attendance and Membership
AC-OPP Members Present:

Dr. W. Berry Lyons, Research Scientist, Byrd Polar Research Center, Chair, AC-OPP

Mr. Raymond V. Arnaudo, Department of State (Ret), member, Advisory Committee, Environmental Research & Education
Dr. Stefanie Brachfeld, College of Science and Mathematics, Montclair State University, Montclair, NJ
Dr. John J. Cassano, Department of Atmospheric and Oceanic Sciences, University of Colorado, Boulder
Dr. Michael D. DeGrandpre, Department of Chemistry and Biochemistry, University of Montana, Missoula (via telephone)
Dr. E. James Dixon, Department of Anthropology, University of New Mexico, Albuquerque (Ret)
Dr. Mark Flanner, Department of Climate and Space Sciences, University of Michigan, Ann Arbor
Mr. Craig Fleener, Senior Advisory for Arctic Policy, Alaska's Governor's Cabinet
Dr. Jose D. Fuentes, Pennsylvania State University, University Park
Dr. Patrick Heimbach, Institute for Computational Engineering and Sciences, The University of Texas at Austin
Mr. Alex Kosseff, American Mountain Guides Association, Boulder, CO
Dr. Donal T. Manahan, USC Dornsife College of Letters, Arts & Sciences, University of Southern California, Los Angeles
Dr. Jo-Ann Mellish, North Pacific Research Board, Anchorage, AK
Mr. Christopher Mossey, Fermi National Accelerator Laboratory, Batavia, IL (via telephone)
Dr. Thomas Neumann, Cryospheric Sciences Laboratory, The National Aeronautics and Space Administration (NASA) Goddard Space Flight Center, Greenbelt, MD
Dr. Leigh A. Stearns, Department of Geology, University of Kansas, Lawrence (via telephone)
Dr. Abigail Vieregg, Kavli Institute of Cosmological Physics, Eckhardt Research Centers, University of Chicago, IL
Dr. Thomas J. Weingartner, College of Fisheries and Ocean Sciences, Institute of Marine Science, Fairbanks, AK (Ret)
Dr. Jeffrey M. Welker, University of Alaska, Anchorage (via telephone)

AC-OPP Members absent:

Dr. Amanda Lynch, Institute at Brown for Environment and Society, Brown University, Providence, RI

Office of Polar Programs (OPP) and other NSF staff present:

Dr. Kelly Falkner, Director, OPP
Mr. Scott Bohnhoff, Section Head, Polar Environment, Safety and Health Section (PESH), OPP
Ms. Gwendolyn Adams, Safety and Occupational Health Manager, PESH, OPP
Dr. Andrew Backe, Management and Program Analyst, OPP
Ms. Kimiko S. Bowens-Knox, Program Analyst, OPP
Dr. Jennifer Burns, Program Director, Antarctic Integrated System Science, OPP
Ms. Jessie Crain, Antarctic Research Support Manager, Antarctic Infrastructure and Logistics Section (AIL), OPP

Dr. Paul Cutler, Program Director, Antarctic Glaciology, Antarctic Sciences Section (ANT), OPP
Ms. Shayna E. Daniel, Conference & Events Specialist, Meeting & Events Section, Office of Information & Resource Management
Dr. William Easterling, Assistant Director, Directorate for Geosciences (GEO)
Dr. Christian H. Fritsen, Program Director, Organism & Ecosystems, Antarctic Sciences, OPP
Dr. Claire Hemingway, Program Manager, Office of International Science and Engineering (OD/OISE)
Dr. Alexandra Isern, Program Director, Research & Logistics Integration, Antarctic Sciences, OPP
Ms. Margaret A. Knuth, Operations Manager, Antarctic Infrastructure and Logistics, OPP
Dr. Doug E. Kowalewski, Program Director, Antarctic Earth Sciences, OPP
Ms. Pawnee Maiden, Administrative Officer, OPP
Dr. Nature McGinn, Environmental Policy Specialist, Section for Polar Environment, Safety and Health, OPP
Mr. Timothy McGovern, Ocean Projects Manager, OPP
Dr. Diane McKnight, Program Director Arctic Observing Network and Arctic System Sciences, OPP
Dr. Jennifer Mercer, Arctic Research Support and Logistics Manager, OPP
Dr. Vladimir Papitashvili, Acting Section Head, Antarctic Sciences, OPP
Dr. Polly A. Penhale, Senior Advisor, Environment, OPP
Dr. Frank R. Rack, Arctic Research Support and Logistics Manager, OPP
Mr. Ben Roth, Facilities Engineering Project -Manager, AIL, OPP
Ms. Kate Ruck, Contractor, Section for Arctic Sciences, OPP
Mr. Paul Sheppard, Deputy Section Head, Antarctic Infrastructure and Logistics, OPP
Ms. Stephanie Short, Section Head, AIL, OPP
Mr. Simon Stephenson, Section Head, Arctic Sciences Section (ARC), OPP
Dr. Marc Stieglitz, Program Director, Artic Natural Sciences, OPP
Dr. James Swift, Chair, AC-OPP Ad Hoc Subcommittee on the U.S. Antarctic Program's Research Vessel Procurement, (via telephone)

Thursday, April 18

Welcome and Introductory Remarks
Dr. Lyons; Dr. Falkner

The meeting began with introductions of all those attending and with Dr. Falkner thanking those who participated in the morning's joint session with the Advisory Committee for Engineering (AC-ENG), which she said was a useful beginning to a dialog for engaging engineering experts on Navigating the New Arctic (NNA).

Turning to the budget, Dr. Falkner said NSF received $295 million more for research and related activities than requested for FY 2018. The agency is in the process of deciding how to spend this increment. Pending Congressional approval, she could not share details but said it was very positive. She also presented good news for the FY 2019 request, noting that the president's request included a large increment for starting Antarctic Infrastructure Modernization for Science (AIMS) construction program, though the Congressional appropriation has not yet been

made. There was also good budget news for NSF's Big Ideas, all of which received big increments, including NNA. She spoke of engaging across the agency for expertise for NNA and enlarging the community that competes.

Updates on Policy Concerning Harassment
Dr. Lyons; Dr. Falkner

Dr. Falkner turned next to updates on the issue of sexual harassment. NSF's policy is that it does not tolerate sexual harassment or any other kind of harassment. NSF expects professional behavior from everyone it supports with Federal funds, including at all research facilities, field sites, conferences, and workshops. All awardee organizations must maintain clear and unambiguous standards of behavior and it is important for them to remind all personnel, including students, of those standards. The foundation cannot afford to have harassment weed out people who might have been positive contributors. Those who create unsafe environments disrupt the entire scientific ecosystem; in particular, women who are harassed are lost to the system. This discourages scientists from contributing, harming their careers and scientific progress, and is contrary to NSF's mission to protect and promote fundamental research and broaden and increase participation in Science, Technology, Engineering and Mathematics (STEM).

Dr. Falkner reviewed how to report harassment to NSF (NSF.gov/harassment) and the role of the Office of Diversity and Inclusion (ODI) in exploring complaints, ensuring all NSF-funded programs and projects are free of discrimination, handling Title IX complaints from NSF-funded program participants, and complaints filed by NSF employees. ODI also conducts Title IX compliance reviews of grantee organizations and departments. NSF may terminate funding to any institution in noncompliance.

Dr. Falkner said the NSF Director, Dr. France Córdova, felt strongly enough about this issue that she put together a group to determine what could be done that would be most impactful. As a result, a special notice was issued to all awardee institutions. These proposed changes to NSF grant terms and conditions, which are in the *Federal Register* and open for comment, require an awardee organization with a finding of harassment for any NSF-funded investigator to notify NSF and place the PI or co-PI on administrative leave. The changes would allow NSF to suspend or terminate an award and require a grantee to replace or remove personnel. The changes are to be finalized in June. She added that NSF employees are responsible for immediately informing ODI of a harassment issue in an NSF-funded program or institution. ODI is also setting up a website, which will soon go live, that will include promising policies and practices from the community that others might wish to consider. The office also conducts Title IX compliance reviews of awardees. ODI can be contacted at programcomplaints@nsf.gov or (703) 292-8020.

Dr. Falkner said an update will be provided in the Fall regarding what was learned from public comments on the proposed changes. There has been a lot of feedback to date, most of which has been supportive. A related hearing was held on Capitol Hill with testimony from ODI and there has been interest from NASA on the proposed new policy.

Discussion

In response to a question from Mr. Arnaudo on the scope of the harassment problem, Dr. Falkner suggested watching the previously referenced hearing, which cited data and studies to systemically gauge the problem, including how many cases there have been. It is clearly a sizable problem, she said, adding there is also more reporting of cases.

Dr. Brachfeld asked about time limits on reporting past cases. Dr. Falkner referenced a case discussed at the prior AC-OPP meeting which went back 20 years but said she did not have an answer. In employment law, the statute of limitations is not that long, she said. Nor is NSF's formal obligation. But universities have flexibility and it can depend on how egregious the offense is and the available evidence.

Dr. Mercer spoke about Arctic field safety training, which is implementing a module on harassment and safe work environments; the first training on harassment and how to report it was well received. The topic of harassment is also being included in user guides for various locations. Any place there is contact with researchers, harassment is being addressed, with clear guidance on how to report incidents.

Dr. Falkner was asked about private sub-contractors and responded there should be no hesitation to report. NSF is cross-sector in everything it does and proceeds on an ad hoc basis. Sometimes the responsibility is with the employer, sometimes with the university that receives the award. There is no cut and dried answer.

Dr. Mercer added that there is an effort to be consistent throughout all the programs, in OPP and beyond. She receives questions from international counterparts regarding those types of situations and the answers are not yet available. If it is under a grant, it would start with the original flow of money from NFS to the institute, but added she was not sure.

Such cases are being handled in the Antarctic currently, Dr. Falkner said, emphasizing the importance of reporting. In addition to meeting higher-level agency objectives, OPP is pushing ahead: there is a code of conduct established for the Antarctic and it is in the process of being made polar-wide. An update is expected in the Fall.

<u>AIMS Communications Planning</u>
Mr. Mossey; Ms. Short; Mr. Roth

Mr. Mossey introduced Mr. Roth to provide an update on the AIMS modernization project and communications outreach. The objective is for the support community to understand the project's implications and receive the collective wisdom of everyone on best communicating the message. Mr. Mossey said he visited McMurdo in February and came away with an appreciation for the diverse nature of the science and the many members of the scientific community supported by the infrastructure. He wants to assure all stakeholders understand the initiative and its implications.

Mr. Roth said AIMS is a rebuild of major portions of the station to better support science in Antarctica. The scope includes:

- The Vehicle Equipment Operations Center
- Utilities: Power/Water/Fire Protection/Cable Plant/Sewer
- Central Services Facility and Utilities and Infrastructure
- Field Science Support Facility
- Station Operating Support Facility
- Lodging

He described a video about the AIMS project that has been useful in explaining the basic effort but it does not include the "how" and "when."

Construction will impact:

- Additional Personnel (Admin, Tradespeople, etc.) on Station
- Site Access: Dynamic Construction Sites
- Utilities: Scheduled Outages, Cutovers
- Operations: Sharing/Scheduling of Equipment
- Logistics: Offloading/Onloading of Material, Ship Scheduling
- Partners: Coordination of Transitions
- Construction: Till 2027

These impacts will be addressed in the communications plan to advise stakeholders that the impacts have been identified and are being managed. Some questions about bed space, fitness facilities, flights, and scientific equipment can be anticipated and answers provided to manage the narrative and reassure all interested parties.

The communications plan will reassure stakeholders that McMurdo will still:

- Serve as logistical hub to near and deep field science and to South Pole science
- Support scientists, support staff, visitors
- Maintain emergency capabilities
- Maintain utilities
- Maintain connectivity
- Adhere to all established Environment, Safety & Health (ESH) and other requirements
- Conduct Regular Operations

The messaging will convey that the station will be open and operational with the same level of medical and emergency care, with the same utilities and business as usual, to reassure that science will successfully be conducted during construction. Mr. Roth expressed interest in hearing from others about communications that might have worked well, or not, for different institutions.

Messages will be tailored to each audience's unique interests and agendas. The major audiences are:

- Congressional
- Internal NSF
    - Major Facilities Panels
    - GEO/Director's Office
    - National Science Board

- ! Institutional/Scientific Community
  - ! Universities
  - ! Others
- ! Strategic Partners
  - ! National Oceanic and Atmospheric Administration (NOAA), NASA
  - ! DoD: Air National Guard (ANG), United States Air Force (USAF), Naval Facilities Engineering Command (NAVFAC), The Space and Naval Warfare Systems Command (SPAWAR)

AIMS Communications tools include:

- ! Social Media
  - ! Facebook
  - ! Twitter
  - ! LinkedIn
- ! Websites
  - ! NSF.gov
  - ! USAP.gov (The U.S. Antarctic Program (USAP))
- ! Scientific Venues
  - ! Council of Managers of National Antarctic Programs (COMNAP)
  - ! Scientific Committee on Antarctic Research (SCAR)
  - ! Conservation of Antarctic Marine Living Resources (CCAMLR)
  - ! Other?
- ! Digital Media
  - ! Antarctic Sun
  - ! Other?
- ! Science, Mathematics, and Engineering (SME) Material
  - ! Office of Legislative and Public Affairs
  - ! Institutional Media
- ! Institutional media
  - ! University Feeds

Some OPP leadership briefs are also made in other NSF venues, including the National Science Board (NSB) and on the Hill.

Mr. Roth concluded his presentation with the AIMS communication timeline:

- ! 30 Apr: Identify and Develop AIMS Communications Team
- ! 30 May: Develop Mission Statement/Charter
  Develop Preliminary Messaging for Audiences
  Populate Message Matrix
- ! 30 Jun: Monthly Meeting
- ! 30 Jul: Monthly Meeting
- ! 30 Aug: Monthly Meeting
- ! 30 Sep: Draft Communications Plan
- ! 30 Oct: Finalize Communications Plan

The 30 Oct. date puts the group in good stead when it comes to the final design review. A draft plan has been prepared but is not ready for release. Mr. Mossey asked for input on other ways to connect with the community, shape the message, add anything that may be missing, or change priorities.

Discussion

Dr. Falkner asked what if there is a real-time situation that requires balancing science and construction. Mr. Roth answered that his first charge is to deliver the station rebuild. A system of messaging can be developed so that when there are contingencies there is a menu of responses. It's just a matter of keeping people informed very quickly and quickly broadcasting anything that is anticipated.

Ms. Short added that there is a method for prioritizing on the ice. There is a close coordination between the NSF representative on the ice, who is an AIL staff member, and an NSF science representative on the ice, who is an ANT staff member. They will make the tradeoffs, as they do now.

Dr. Papitashvili referenced the past modernization of the South Pole Station to say the involvement of all program officers and the entire science section is helping, even with ongoing activities. On a day-to-day basis, the community should be kept informed from program officers.

Dr. Neumann suggested repeatedly communicating how issues will be resolved in as many different venues as possible. Regarding communication tools and scientific venues, he said American Geophysical Union (AGU) Town Hall sessions are well attended and noted there are many other science societies that could be considered. Making people aware of the scope of what is going on in any particular year may flavor what science they want to propose and will help maintain community support.

Dr. Brachfeld said PIs will consider this issue first when doing their proposal and Support Information Package (SIP). The SIP should include updates on facility availability. Dr. Manahan said the SIP is complicated enough as is and commended the AIMS video and remarked on the 2027 completion date. Mr. Roth said the completion date was set in order to accommodate science throughout construction. No functions in the current portfolio of activities will be removed until it is replaced by a new facility that is operational. The SIP is completed about this time of the year for the field season that starts in October, Dr. Lyons said.

<u>Review of Meeting with AC-ENG</u>

With time remaining on the schedule before the next agenda item, Dr. Falkner first asked IT Specialist Douglas Baggett, with the Division of Administrative Services, to introduce himself. Next, she next asked for a summary of the morning's exercise with the AC-ENG.

Dr. Weingartner said there was a healthy conversation on the issue of how the Engineering Directorate can work with Arctic and Antarctic sciences to identify issues that can be tackled with an engineering approach. No part of engineering was found irrelevant to the issues of

scientific investigation in either region. The engineers were very interested in some of the issues, which they had not previously thought about, making the session helpful in terms of informing the two disciplines of what they can do for each other. Seeds were planted and interest generated on both sides.

Dr. Lyons said there were four tables for separate discussions at the morning session and asked if that format would be followed when AC-OPP meets with the Advisory Committee for Environmental Research & Education (AC-ERE). Dr. Falkner said a different approach had been agreed to with AC-ERE.

Dr. Manahan said his table's topic was about what is fundamental to engineers. One interesting comment was about polar scientists not seeing engineers as just fixing stuff. There has to be something profound to engage NSF engineers. The question arose: What are the profound paradigm shifts in engineering that would emerge from studying extreme environments?

Dr. Heimbach raised the issue of the extent to which engineering serves the local communities and whether engineering solutions help to solve social and economic problems. There was also a tension between urgent needs and the rapidly changing Arctic, which is a problem now.

Dr. Falkner said ERE recently released *Sustainable Urban Systems: Articulating a Long-Term Convergence Research Agenda* (January 2018) (https://www.nsf.gov/ere/ereweb/ac-ere/sustainable-urban-systems.pdf). The report addresses the science to address life in urban settings. Globally, 66 percent of the population is in urban areas, with 85 percent in the U.S. She referenced a morning presentation given by Dr. Matthew Jull, Assistant Professor of Architecture at the University of Virginia, who is Director of the Arctic Design Group, who is thinking about reimagining urban Arctic settings. The AC-ERE has this issue on their agenda. Dr. Deborah J. Goodings, Division Director, Division of Civil, Mechanical & Manufacturing Innovation (ENG/CMMI), also made a presentation and speaks for important issues that OPP needs to tackle, Dr. Falkner said. She was encouraged by the morning's conversations, adding that follow-up is needed.

In response to a question from Mr. Mossey about sensors, Dr. Falkner said there was a discussion in the morning recognizing the need for new sensor types and engineering them to take advantage of artificial intelligence. They also discussed optimizing observing.

Dr. Stephenson said his table at the morning session discussed balancing knowledge of physical and biological systems that exist with the observing sensors. The engineers were interested in that development but wanted guidance about what to sense.

Dr. Heimbach said the engineers talked from an aerospace perspective and translating it to the Arctic environment and putting out many micro sensors and the cyber infrastructure to get the data in real time, how to evaluate them, and optimal sensor placement.

Dr. Weingartner said the engineers in his group brought up and were excited about data analytics, robotics, materials science, and operating in extreme environments.

Dr. Dixon said his group discussed collaborating with indigenous people and Arctic residents in terms of moving forward on engineering design, particularly as they affect communities. They also discussed the recently released report, *Arctic Horizons*, with deals with the social sides of NSF. He added that the engineers were largely unaware there was a social science program within Polar Programs.

Dr. Falkner added that her table had much to say about training young people in a way that is pragmatic regarding immediate issues and inspiring the next generation of engineers and scientists.

Dr. Lyons said the engineers around every table were excited about continuing the dialog and there was discussion about future workshops with the two groups.

Joint Session with AC-ERE
Dr. Lyons; Dr. Falkner

Dr. Lyons asked AC-OPP, visiting AC-ERE members, and others attending to introduce themselves.

Visiting AC-ERE Members:

Dr. Anthony Janetos, AC-ERE Chair and Director for the Study of the Longer-Range Future, Boston University
Dr. Pedro J. Alvarez, George R. Brown Professor of Civil and Environmental Engineering, Rice University
Dr. Tina Bahadori, National Program Director, Chemical Safety for Sustainability Research Program, United States Environmental Protection Agency
Dr. David E. Blockstein, Executive Secretary, Council of Environmental Deans and Directors
Dr. Ann Bostrom, Faculty Coordinator, Evans School Ph.D. Program in Public Policy & Management, Weyerhaeuser Endowed Professor in Environmental Policy, Daniel J. Evans School of Public Policy & Governance, University of Washington
Dr. Andres F. Clarens, Professor, Department of Civil and Environmental Engineering, The University of Virginia
Mr. Roger-Mark De Souza, President, Sister Cities International
Dr. Maria Carmen Lemos, Professor and Associate Dean for Research, School of Natural Resources and Environment, University of Michigan
Dr. Richard Loft, Director of Technology Development, National Center for Atmospheric Research
Dr. Margaret Lowman, Director of Global Initiatives, Senior Scientist & Lindsay Chair of Botany, Institute of Science & Sustainability, California Academy of Sciences
Dr. Patricia Matrai, Senior Research Scientist, Bigelow Laboratory for Ocean Sciences
Dr. Julia Parrish, Associate Dean, College of the Environment, University of Washington
Senior Scientist, National Council for Science and the Environment
Dr. Diane Pataki, Professor, Department of Biology, University of Utah (telephone)
Dr. Anu Ramaswami, Charles M. Denny, Jr., Chair of Science, Technology, and Public Policy, Humphrey School of Public Affairs, University of Minnesota

Other Joint Session Visitors:

Dr. Suzi Iacono, Head of the Office of Integrative Activities (OIA)
Dr. Leah Nichols, OIA, Executive Secretary for AC-ERE

Dr. Falkner welcomed the AC-ERE, briefly reviewed the AC-OPP's history and role, described the morning's session with the AC-ENG, and provided some highlights from her earlier budget presentation.

Dr. Janetos said his committee's charge is to look at the environmental research and education portfolio across the foundation, commenting and identifying new strategies, topics, and new areas where the foundation can play a leading role. He referenced a September 2015 report, *America's Future: Environmental Research and Education for a Thriving Century*, also known as the Gold Report (https://www.nsf.gov/ere/ereweb/ac-ere/ac-ere_thriving_century.pdf). The report emphasizes the importance of design and prediction. As environmental research matures, the challenge is to design more sustainable systems. AC-ERE's challenge is to identify areas where collaborations among NSF directorates are critical for making progress. An example is the *Sustainable Urban Systems* report, which identifies different forms of decision-making and the physical consequences of decisions past and future and their implications for human well-being. This plays into agency priorities such as NSF's Smart & Connected Communities effort. In the last year and a half, AC-ERE has spent significant time specifically on environmental issues related to national security and economic competitiveness. Those connect with NNA and other aspects of polar research. He concluded by saying he was looking forward to the joint session and hearing where OPP is on NNA and starting an exchange.

NSF Big Idea: Navigating the New Arctic
Dr. McKnight

Dr. McKnight, who co-chairs the working group of program officers involved in NNA, began her NNA presentation with the February 2018 Dear Colleague Letter (DCL), which says that proposals may focus on such topics as:

- Establishment of observational research sites, platforms, or networks
- Understanding and forecasting environmental and human systems changes
- Feedback between built infrastructure (rural and urban) and natural ecosystem and/or social system change
- Advances in STEM education through Arctic research

Regarding the first topic, Dr. McKnight noted there is language about closed-loop cyber-physical systems, which entails real time communication back to communities that live in the Arctic. The current DCL builds on a 2017 DCL with opportunities for research coordination networks and workshops addressing issues in the New Arctic in a convergent manner. Two of the three proposals awarded were on coastal erosion, led by civil engineers from Penn State and the University of Alaska at Anchorage. One workshop involved new systems of Arctic transportation. The current DCL also includes systems approaches to questions, leveraging large data sets, knowledge co-production, public participation, and international partnerships.

The management plan identifies convergence using definitions from the Convergence Working Group:

- Research driven by a specific and compelling problem. Convergent research is generally inspired by the need to address a specific challenge or opportunity, whether it arises from deep scientific questions or pressing societal needs.

- Deep integration across disciplines. As experts from different disciplines pursue common research challenges, their knowledge, theories, methods, data, research communities and languages become increasingly intermingled or integrated. New frameworks, paradigms or disciplines can form from sustained interactions across multiple communities.

Dr. McKnight said it useful to think of convergence as a whirlpool, where the focus on a problem brings different disciplines together.

Knowledge co-production is identified at NSF as:

- Research in which local and indigenous people and organizations fully engage in the complete research process from development of questions, to collection, use and stewardship of data, and interpretation and application of results.

Co-production involves integration of traditional ways of knowing from beginning to end, she said. Communication of results to communities will be viewed by NNA as a valuable attribute of incoming proposals.

Dr. McKnight concluded her presentation with a brief timeline update. The target time for proposal submission is May 1 and there is a plan in place for managing submissions.

Dr. Falkner described structures for engagement at all levels across the foundation for the DCL. Dr. McKnight worked hard on putting together the DCL, which was signed by Dr. Easterling and his colleagues at the Foundation. Dr. Falkner coordinated the steering committee with Dr. Kellina M. Craig-Henderson, Deputy Assistant Director for the Social, Behavioral and Economic Sciences (SBE) Directorate, and Dr. Goodings.

<u>Open Discussion of OPP & ERE Convergence on Navigating the New Arctic</u>

Dr. Lyons opened the session for discussion of convergence on NNA.

Dr. Parrish asked about the international component of NNA. Dr. McKnight responded that there is strong guidance on principles for conducting research in the Artic that addresses the issue, beginning when proposals are considered for award. It is case by case and Research Support and Logistics (RSL) Program Officers (PO) are involved. NSF wants to avoid Arctic research that creates unnecessary issues and wants to successfully engage communities, not just in Alaska.

Dr. Janetos raised the question of how the advisory committees think of convergence and analogized it to a washing machine. AC-ERE considered cases where methods, theories, and intellectual histories of disciplines inform each other. He expressed concern about having people

in multiple silos working on a problem and asked how this is considered in the solicitation and at the point of reviewing proposals.

Dr. McKnight said the DCL encourages, but does not require, a convergent approach. There may be proposals that address topics that would not require a convergent approach. But where a convergent approach is appropriate, she would be looking for it in the context of the NNA working group. If there is research where it makes sense to bring in a particular field that is left out, that would not be convergent. In the washing machine analogy everyone gets clean clothes, she said. But in a whirlpool, a focus on the problem promotes integration and avoids distractions from other disciplines, which are not essential to the problem.

Dr. Easterling said he had difficulty when first at NSF distinguishing the term convergent science from what he had known as well-integrated interdisciplinary science. There are nuances that can make convergent science a more powerful form of interdisciplinary research. NSF is looking toward a form of integration where the right people are at the table in equal measure at the beginning of the project when the methodological decisions are being made and the approach is to build models from the ground up. He contrasted this with pulling a model off the shelf and finding a way of having it talk to another off-the-shelf model, creating a less than perfect union. NSF is trying to build from the ground up a methodology that brings the social, physical, and life sciences together to deliver a fully synthetic whole product that is greater than the sum of the parts.

Dr. Lowman asked if Antarctic research can be business as usual and retained as in the past and if some educational aspects of polar science will be reinvented to help understanding of the differences between the poles. Dr. Falkner answered that Antarctic science will continue to thrive. There are different conditions in the Antarctic, without the native population, and do not have the social science drivers. But geopolitically, what is accomplished there on behalf of the world is very important, and thus has a social element. There is also a massive overhaul of Antarctica infrastructure with a new future envisioned there. For NNA, there is an attempt to get people to think innovatively. Dr. Arnaudo pointed out the global cooperation and peace at the polar regions.

Dr. Lemos asked about the private sector and participation in light of new commercial routes. Dr. Falkner said AC-OPP was interested in AC-ERE's views on this, adding there are opportunities for partnerships to leverage NSF's effort. There are already traditional partners interested.

Dr. McKnight went back to the awards for last year, which included a workshop on preparing for a northwest passage and said SBE is a participant. It is not yet known whether there will be proposals in the area Dr. Lemos referenced. The workshop addressed if there will be any implications for New England.

Dr. Manahan asked for advice for how to do a better job providing education about the poles. Dr. Lowman discussed her work with virtual expeditions (the Jason Project). She took the Jason Project all over the world and it is now being reinvigorated. With new technologies, you can take

every kid to Antarctica. She also said it would be possible to cooperate with corporate partners for further virtual polar educational projects.

Open Discussion of ERE, Polar Research, National Security, and Economic Competitiveness

Dr. Lyons opened the discussion by asking for an outline of what AC-ERE has been doing in this area.

Dr. Janetos said AC-ERE looked at the assumption that environmental research retards economic growth, which he said is not correct. There are relationships between environmental factors, economic growth, and competitiveness that are not well understood and should be active topics for research. AC-ERE is preparing a DCL to go out at the end of April that will serve as a Request for Information (RFI) and go out broadly to the scientific community to ask for their thoughts and recommendations. From the responses, AC-ERE will synthesize recommendations for NSF.

As an example, he raised the question of whether large-scale changes sea ice cause an increased number of Nor'easters during the late season. Also, if a shorter passage opens from East Asia to Europe, it will be a game changer for the manufacturing sector and fundamental research is needed to determine if that is likely. Dr. Falkner said NSF's European counterparts are thinking along the same lines, which they present in terms of research investment.

Dr. Fleener asked if this is the convergence of national security and economic competitiveness, or whether they are two separate ideas. If it is the convergence, it can change the shape of the world and there is a lot to evaluate. Dr. Janetos responded that they started as separate themes but said he could not predict the outcome. There are interconnections but AC-ERE wants to make sure there is a tangible connection to high-priority research themes NSF can go after. The committee is looking at security in a broad sense, beyond national defense.

Dr. Fleener followed up by mentioning economic expansion in the Arctic and the lack of technological capacity in Northern Canada and Alaska to handle expansion. There are no medium-sized or large ports in the Arctic. Corporate plans for sending 1,000 container ships through that area are being scaled back. But even 100 ships would pose problems of waste and spills. He also mentioned the lack of infrastructure as a problem.

Dr. Bostrom returned to the importance of emphasizing education in NNA and a collaborative venture with EHR. Dr. McKnight said EHR is actively involved and one of the working group members is involved with the Tribal collages. With Cyber-Physical Systems (CPS), co-production, and public engagement, there is a strong education aspect. Decisions about which research areas communities want to get involved in may be based on where they need to gain capacity for the future, such as understanding water in their environment, and should be seen as connected.

Dr. Loft asked if others saw a connection with abrupt climate change? He referenced a German paleoclimate project that ran for 10 years and said there was no similar research agenda in the U.S. Dr. Falkner said there was active support of paleo science in the ice core community and the

oceans community. There is also paleo investment in the polar realm. Dr. Stephenson added that NNA is part of a broader portfolio. There is a program, Paleo Perspectives and Climate Change, which has a polar component, and will continue with the convergent research. Dr. Loft responded that the German program integrates modeling and data to answer questions on our time horizon, not since the Last Glacial Maximum (LGM), and considers it an important security issue.

Dr. Blockstein added that there is a New Arctic because of climate change and that NSF's investment in climate change education is needed.

Dr. Heimbach mentioned a U.S. Atlantic Meridional Overturning Circulation (AMOC) science team and said a paleo AMOC report was issued. They have been trying to bring in people from different sectors to understand the prospects of fresh water inputs into the North Atlantic. Dr. Loft noted that there were connections between the team Dr. Heimbach referenced and the European effort.

Dr. Lyons thanked everyone and said he looked forward to future joint sessions. Dr. Janetos also thanked everyone and said he hoped the two committees could meet together again. Dr. Falkner said AC/GEO will try for a way to keep intersecting with AC-ERE outputs, perhaps through the committees' websites.

Strategic Planning – Part 1
Dr. Lyons; Dr. Falkner

Dr. Lyons opened by asking Dr. Falkner for an overview from the perspective of GEO and others.

Dr. Falkner referenced the AC-GEO report, *Dynamic Earth: GEO Imperatives & Frontiers 2015-2020*, which includes what it calls imperatives, or items that must be done, and frontiers, or items over the horizon to pay attention to. AC/GEO decided to update *Dynamic Earth* with an addendum. The breadth of OPP's interests are not strongly represented in *Dynamic Earth*. AC-OPP is therefore looking at recent studies to synthesize a bigger picture for OPP. Before AC-OPP was stood down, it was working on a strategic planning document that defined what OPP does and things important to consider about what OPP does, comprising a collective understanding of OPP's vision. This includes the geopolitical importance of activities at the poles, which is not necessarily included in existing documents. Nor is harassment. Therefore, the document AC-OPP creates can provide OPP's unique value set as well as a look across operations and science at important polar topics. This could be framed as imperatives vs. frontiers. AC-GEO hopes to have its addendum starting to go through clearance by September for rollout at their Fall meeting. How AC-OPP feeds into AC-GEO's process will depend on how much progress is anticipated. She concluded by advocating for a short document.

Dr. Vieregg said it was good to understand that the charge is to put together a strategic plan, rather than a laundry list and that someone was needed to take the lead. Dr. Falkner said there is only one NSF "strategic plan." It uses the acronym ExPLICIT (for Excellence, Public Service, Learning, Inclusion, Collaboration, Integrity, Transparency) and AC-OPP might consider creating an acronym in similar fashion to increase its document's memorability. The June 2013 AC-OPP document, *Recommendations for Polar Programs*, may need to be updated and expressed so it can be memorable.

Dr. Lyons said a draft document (Synthesis for AC-OPP meeting) was compiled from individual contributors and apologized for it not citing Dr. Heimbach, who also contributed. It covers the similarities in all of the documents consulted and their important recommendations. The Polar document is just the beginning of the process and someone is needed to lead the next stage of the document's development, which will have to be done before the next meeting.

Dr. Falkner made an analogy to a question Congress asks the NSF director: "How do you prioritize science at NSF and how are you deciding among the areas?" She said it would be useful to capture that kind of prioritization for OPP.

Dr. Lyons said it was important to be organized and come up with a plan tomorrow for what the committee needs to do.

Dr. Dixon said the draft did not provide a sufficient social sciences point of view and suggested consulting the recent *Arctic Horizons — Final Report*. He recommended at least one bullet about the importance of the social sciences, framed in terms of Arctic research, synthesized from the data and priorities in *Arctic Horizons*. Dr. Dixon said this is his last AC-OPP meeting, so he may not be the best person for this task.

Dr. Lyons asked for help from members who did not contribute to the Synthesis document.

Dr. Falkner noted that a third of the AC will be turning over, but not until the Fall meeting and urged consideration of how to organize for now and about passing the torch.

Mr. Fleener spoke for the much-needed concept of supporting science that informs decision-making. The Synthesis document needs a better feedback loop that includes what the decision makers want and need and he asked if that will be included, versus the document being researcher driven. If the latter, it will be funding driven and likely someone's pet project rather than what policy decision makers need.

Dr. Manahan emphasized the hard work of subtracting, rather than adding to the list, to determine what is imperative.

Dr. Heimbach said the Synthesis document was a list of points from other reports as a summary from which to draw on. He suggested finding the structure of the report to be written with overarching themes, for example, cyber and hardware infrastructure, expanding observing system capabilities for science, and specific science questions.

Dr. Dixon said curricula vitae of the authors were implicit in the document. It is important to make it societally relevant, which is the power of it socially and politically. Social relevance is critical to the success of the document, which he said is not coming through.

Dr. Brachfeld asked: Who is the audience and how will it be used? Dr. Falkner said every AC has a similar document to advise about important areas of investment. The audience includes Congress and NSF leadership, which value the community thoughts about what the priorities should be. It should express OPP's priority agenda. It is also important to have the community comment on it and to assimilate those comments into a final version. OPP can help with that

and other aspects.

Dr. Lyons added that the AC's charge was to summarize what came before, not adding new material but creating a synthetic interpretation. There is also an opportunity to add new things but that is not what this document was meant to do.

Dr. Flanner asked if the previous Polar document (*Recommendations for Polar Programs*) could serve as model. Dr. Falkner responded that it fell short of what AC-OPP is attempting. It tried to establish at a high level the important things OPP does. However, it does not use the imperatives and frontiers approach. But it may include things to build on. Dr. Flanner also asked how much the AC should impose its own expert judgement on the document. Dr. Lyons said the committee should try to do that. Dr. Manahan said the AC is a committee of experts and that is its role. He reiterated the point made earlier about whether the document is to be research driven.

Dr. Mellish said the three statements at the document's beginning make a lot of sense and can be translatable to a wide variety of stakeholders. She appreciated the list of documents that were synthesized. The idea of imperatives and frontiers can be built from the three simple definitions that are used. Dr. Lyons said those three points were spelled out in a lot of the documents, but they are not very specific. The committee tried to integrate what had been done before. But if what was written was thrown out, that would be okay.

Dr. Falkner referenced Mr. Fleener's point and said there is a need to justify what OPP does and its expenditure. The document, she said, doesn't speak broadly to justification.

Dr. Weingartner said one of the reports consulted was about the Anthropocene, which includes significant information on human and societal issues. The first three bullets in the Synthesis document can easily be modified to highlight the issues that Mr. Flanner raised.

Dr. Lyons agreed and said one priority identified in a National Academy of Sciences report on ice sheet stability and sea level rise can easily be tied into society. Dr. Weingartner added that some of the points in the Synthesis document can be altered to emphasize the science issue rather than the required approaches. Dr. Lyons said the authors shied away from pushing specific science issues to be egalitarian. Being face-to-face would help avoid that.

Dr. Vieregg said the three points at the top of the Synthesis document do not read as science driven. She said it is a challenge prioritizing ice sheet stability and the Big Bang. Dr. Falkner responded that the committee embraces OPP's broad responsibility and the document does not have to prioritize within OPP. Dr. Vieregg said there's a challenge in striking a balance between a laundry list of what everyone would like to do and embracing the discipline's broadness, but it will be informed by what the individual communities have prioritized.

Dr. Weingartner suggested the opening set of points be stated simply. For example, What is the direction of productivity in the Arctic? It has large implications for people living there and those who might eventually take advantage of biological productivity in Arctic, if it goes in that direction. Also, what is the impact of the Arctic on mid-latitude weather? Another issue is sea level. He also mentioned cosmology being an attraction to STEM education. He suggested making simple statements or questions to introduce important topics. A summary paragraph can state why it has important implications on humans and our economy. Dr. Falkner added that OPP

has operational responsibilities to support what OPP does, which also need to be expressed.

Mr. Stephenson addressed questions from Mr. Fleener about existing statements of research needs, overarching documents (e.g., from the Arctic Science Ministerial), and specific written agency requirements. He referenced a Federal interagency science plan from The Interagency Arctic Research Policy Committee (IARPC), which addresses non-security issues and focuses on areas where interagency collaboration should play a significant role, rather than what the agencies are funding. He also mentioned the Sustaining Arctic Observing Networks (SAON) initiative and the International Arctic Science Committee (IASC), which includes the integration of natural and social sciences. The IARPC document is recent and a reasonable starting point. Mr. Fleener said he was more interested in each agency's laundry list to help understand what is needed so the AC can condense it. IARPC does not do all the individual areas needed for research.

Mr. Stephenson added, in response to a follow-up from Dr. Falkner, that SAON used the societal benefit areas and the Europeans are co-funding an effort to take that a step further. It was very significant when U.S. GEO did it for the U.S. observing capacity, he said. The SAON plan may not have the same level of rigor. It includes local Arctic knowledge needs in a helpful way but misses the Arctic in the global sense. Dr. Falkner said the SAON link would be provided to the committee. She added that not everyone knows the breadth of what OPP does. It is easy to forget how little outsiders know of what the unique things OPP does, even those within NSF. Therefore, there will be a lot of use for the document AC-OPP is creating to express what is important about who we are.

Dr. Lyons said the discussion would resume in the morning, with assignments made. He adjourned the meeting for the day.

Friday, April 19

Strategic Planning – Part 2
Dr. Lyons; Dr. Falkner

Dr. Lyons announced that Dr. Heimbach has developed a straw proposal for the Strategic Planning document to focus the discussion.

Dr. Heimbach used the *Recommendations for Polar Programs* document and the Synthesis document the AC drafted to create a new document, organized around Why, How and What. The Why section lists the following points:

1. Polar science
2. Science at the poles
3. People in polar regions
4. Artic geopolitics and sustainability
5. Polar education and education in the polar regions
6. Empowerment in polar regions

Dr. Heimbach explained that science at the poles can be unique activities, such as certain physics experiments vs. polar science, which is some of the natural science having to do with polar ice sheets, sea ice, and connections to mid-latitudes. Together, this first set of bullets covers why science is being done at the poles.

The How section pertains to how science is done at the poles:

1) Infrastructure and access
    i) Fixed and mobile logistics and hardware
    ii) Modern cyber infrastructure
2) (Long-term) observing platforms and networks
3) Computational science and engineering to support understanding and prediction
4) Education and outreach

Dr. Heimbach said the above points ("How") come back to the Synthesis document and fit into the *Recommendations for Polar Programs* document.

The What section highlights what is done at the poles:

1. Core research
    A. ...
2. Systems research
    A. …

The above points ("What") align with Page 2 of the Synthesis document and the science questions, where more detail is provided on the science that should be highlighted.

Discussion:

Dr. Lyons asked if under the What section the committee can draw on the other reports members have read that emphasize the most important science issues. Dr. Heimbach said that was correct and said that information was captured in the Synthesis document and under the keywords and subsequent bullets in the *Recommendations for Polar Programs* document, all of which is motivated by the How and Why sections.

Dr. Weingartner said he liked the outline and suggested modifying the Why section to say: "People and polar science."

Dr. Vieregg said the Why section lines up with the idea of imperatives and frontiers. It can be seen as polar science being the imperatives, or about the poles, and science at the poles referring to pushing the frontier of that science by going to the poles. People at polar regions may fall under the imperatives as things that can only be done at the poles. Dr. Falkner said GEO reserved the word "frontiers" for more aspirational, over-the-horizon work that would be done if more resources were available. She said Dr. Vieregg was using "frontier" more as it is commonly used. Dr. Vieregg asked if there was a snappier packaging. She liked the idea of science about the poles that's important to learn about versus pushing the frontier of science by going to the poles, adding that she was referring to more than astrophysics and cosmology. Dr. Falkner added that someone else might suggest space weather.

Dr. Lyons asked if yesterday's discussion of social relevance would fit under Why. Dr. Heimbach said it would, under the heading, people in polar regions, which also includes geopolitics.

Mr. Arnaudo asked if Antarctic geopolitics were being ignored. Dr. Heimbach responded that

the wording should use "polar" instead of "Arctic."

Mr. Fleener said he liked the simplicity of answering the Who, What, and Why questions, especially to reach those who are not engaged and appeal with a document that is easy to understand. He also liked Dr. Vieregg's point about being snappier, but did not want to lose the Who, What, and Why. He suggested adding the subtext of imperatives and frontiers.

Dr. Flanner thanked Dr. Heimbach for getting the work started and raised a question about combining geopolitics and sustainability. Sustainability was important to AC-OPP's earlier discussion of NNA. Though geopolitics also came up, he asked if it belongs in this outline or should stand alone. He asked about the role of NSF in geopolitics and whether it is needed.

Mr. Arnaudo said geopolitics are real and pointed to the issue of Chinese overfishing. Dr. Falkner added that it was good to question if it is tightly related to sustainability. But she reminded the committee that OPP has a mandate for the Antarctic side to run a program on behalf of the nation, which has an inherently geopolitical flavor. To have a governing role there has to be an active and influential science program. For the Arctic, there is no mandate to be the only coordinating agency across the U.S. government, although the director is the chair of the IARPC and will represent the U.S. in October at the Second Arctic Science Ministerial. The profile for the Arctic was raised during the U.S. chairmanship of the Arctic Council, which is a science-driven body. Within approximately one month, all of the countries are expected to have deposited on the agreement to enhance science cooperation at the poles for the Arctic. In the polar regions, geopolitics is part and parcel of what OPP does. She asked if Mr. Arnaudo thought the words geopolitics and sustainability should not be on the same line and he responded affirmatively, adding that much in the world of sustainability is not related to geopolitics.

Dr. Dixon complemented Dr. Heimbach on the document he prepared, particularly starting with Why. More work is needed, he said, while endorsing the overall structure.

Dr. Mellish said she liked how the document splits polar science and science at the poles, which seem like the same thing to some people.

Mr. Fleener said he did not see as much of a connection between geopolitics and sustainability as the document implies, but said it is important to keep the list to six or seven items. He raised the issue of combining the first (Polar science) and second items (Science at the poles) under Why, which he said are closer than geopolitics and sustainability.

Dr. Lyons asked about combining sustainability under the third item (People in polar regions). Dr. Heimbach answered affirmatively. He added that sustainability also affects ecosystems and biological systems that are not people and suggested that sustainability captures that distinction. Dr. DeGrandpre said sustainability was used in one of the reports that were reviewed to refer to NSF's ability to sustain long-term observations. Dr. Lyons said he heard a consensus for breaking out sustainability as a stand-alone item.

Dr. Cassano suggested that the Geopolitics item be combined with the item "People in polar regions." Dr. Dixon wondered about the Antarctic, where there is an international mandate and no residents, making it different. He also questioned the word "geopolitics." He said the term is loaded. But there is a clear mandate for Antarctic research. In the Arctic he said it is more

geopolitical. Sustainability, he added, should be separated out, because of the biological side, etc.

A member of the audience suggested this was an opportunity to relate polar sciences to other sciences.

Dr. Stearns asked about the meaning of empowerment in the polar regions. Dr. Heimbach responded that it refers to increased diversity regarding people in polar regions and researchers in Arctic regions, as well as issues of harassment. He said it should perhaps be included under "People in polar regions," rather than as a standalone item. Dr. Stearns said it folds into a number of the headings and suggested it be the What or How in how the other topics are being addressed. Mr. Fleener asked if sustainability and empowerment could be sub-bullets because they come up in multiple sections. He also questioned separating out sustainability of people, sustainability of funding, and the sustainability of research stations versus including sustainability under the heading, "Science at the poles" and "People in polar regions."

Dr. Manahan thanked Dr. Heimbach and said it provided a good structure to go forward. He volunteered to help write the document and lead the effort. Dr. Brachfeld and Dr. Weingartner also volunteered to help with the writing.

Mr. Arnaudo said there were references in the Synthesis document the Strategy Subcommittee prepared to the Antarctic treaty and wording should be added about the Arctic Council. He volunteered to provide the wording. Dr. Dixon volunteered to take data from the *Arctic Horizons* report and provide bullets to the writing team.

Dr. Manahan said the document can be completed by the end of May and requested staff help with visuals. Dr. Backe will serve as point of contact. Dr. Weingartner and Dr. Vieregg said they would also contribute bullet items. Dr. Manahan summarized AC-OPP's role as looking at the strategy issue independently and providing imperatives that can't be walked away from or frontiers the committee is thinking about but which are not as critical.

Dr. DeGrandpre added that he hoped Dr. Manahan's writing group would use the Strategy document and the document Dr. Heimbach presented. Dr. Manahan said the task is to turn that material into a two-page document that includes more narrative. Dr. Lyons said NSF's Big Ideas document should also be represented. Dr. Flanner urged that the new document be easily readable in electronic format. Dr. Manahan said several of the Big Ideas would be good to highlight.

Dr. Lyons summarized that a writing committee of three was formed with Dr. Manahan as the lead. Dr. Dixon, Dr. Arnaudo, and Dr. Vieregg will also contribute. A first draft will be completed by June 1 and sent to everyone for comments and edits. A final draft will be done for the October meeting. Dr. Manahan said it would be easy to write two pages by then, but Dr. Lyons said the length should be eight to 10 pages. Dr. Manahan said the committee's previous document included two pages of text, without graphics. Dr. Heimbach suggested four pages of text. Dr. Neumann referenced the 2013 *Strategic Imperatives, Division of Polar Programs* document and said its narrative would be helpful to reference. Dr. Falkner said the committee was free to borrow from that document.

Dr. Falkner asked Dr. Easterling to talk about AC-GEO's efforts to update *Dynamic Earth*. Dr.

Easterling said when he arrived at NSF last spring he studied *Dynamic Earth*. He did not have the appetite to suggest a new strategic planning activity because *Dynamic Earth* had recently been completed. Instead, he had an ongoing conversation with division directors and Dr. Falkner over opportunities that may have arisen over the last few years that are not well articulated in *Dynamic Earth* and whether priorities have we changed. This became a topic of discussion with AC-GEO, which agreed to poll the community and have a conversation on what new ideas ought to be considered, looking to the next five years. AC-GEO has since been soliciting community input and is about to look through the responses and will be discussed when AC-GEO meets next week. Dr. Easterling said he was not prepared to say anything of substance about the findings except that, as expected, there has been much advice about new questions GEO should be considering.

In talking science with the division directors, GEO began to see some opportunities that derived from the future-looking part of *Dynamic Earth* having to do with coastal questions, trying to get a better handle on the Transocean subduction processes, having a better understanding of what is driving geographic differences in rates of sea level rise, and what happens to severe coastal storms as they transition to from a maritime to a terrestrial environment. It became clear there might be value gained by looking at these sources of geophysical hazard in a coastal environment, particularly given that most cities of more than 10 million are on coastlines and that in the future the global coastal population will grow further. By the latter third of the century, as much as 70 percent of the world's population may be living within 100 kilometers of a coastline. This makes a persuasive case for having a focus on coastlines and people. Dr. Easterling commissioned a Working Group in GEO that is branching out to the rest of the foundation. There is a great deal of interest in coming together over this opportunity. Dr. Easterling said there were ties to OPP and offered a formal presentation.

Dr. Dixon asked about the status of the planned continuous representation with GEO that had been discussed when AC-OPP was formed and asked if there was overlapping membership. Dr. Falkner said a couple people will be on both committees with additional AC-OPP representation on AC-GEO. Dr. Easterling said that as AC/GEO members rotate off there is a plan for overlap and continuous information exchange. Dr. Welker will be moving from the AC-OPP to AC-GEO.

<u>Polar Research Vessels and Icebreakers</u>
Dr. Weingartner; Mr. McGovern; Mr. Sheppard; Dr. Rack; Dr. Swift

Dr. Falkner introduced the presenters for the next session.

Dr. McGovern began his presentation noting that in FY 2016, OPP began funding the support contractor to hire a re-procurement manager for the research vessels (R/V), which are approaching end-of-contract dates. The Antarctic Support Contract (ASC) hired Mr. Chris Chuhran, who was a project manager and vice president at Guido Perla & Associates. Last year ASC subcontracted with Glosten Associates, which has assisted with draft technical documents.

Last month OPP created a subcommittee to assist with procurement, chaired by Dr. Swift. Members include Mr. Randy Sliester, Dr. Amy Leventer, Dr. Kim Bernard, Mr. Michael Prince, and Dr. Weingartner (AC-OPP liaison).

Dr. Weingartner continued the presentation, noting the subcommittee has had two meetings by telephone so far and plans to continue on a weekly basis. A report will be issued by September and another presentation will be made to AC-OPP in the Fall. He presented the subcommittee's underlying purpose:

- "a new vessel procurement solicitation needs to be developed that ensures the Antarctic scientific community is continued to be supported with state of the art sea-going facilities designed to operate in these harsh environments."

He said the subcommittee directive is to:

- "Review and assesses the science mission requirements and operational capabilities of replacement Antarctic research vessels." The report should "specifically state whether or not the Subcommittee feels the vessel specifications as outlined will adequately support sea-going science in the Southern Ocean and along the Antarctic Peninsula" … and "may include recommendations to NSF for further improvement of the specifications."

Dr. Weingartner presented the specific tasks assigned to the subcommittee:

1. "Review and verify the continued validity of the University-National Oceanographic Laboratory System (UNOLS) 2012 Polar Research Vessel Science Mission Requirements, the 2016 NSF-OPP Antarctic Vessels Request for Information, and the 2018 ASC-provided Vessel Studies Reports."
2. "Prioritize each proposed vessel's capabilities and operational requirements."
3. "Consider the two-ship operational model of the US Antarctic Program, and evaluate the advantages and disadvantages of moving to a one-ship operating model."
4. "Engage the broader scientific community to ensure vessel capabilities and characteristics are able to meet a majority of anticipated needs for the duration of the 10-year charter, and possibly for the lives of the vessels (~ 30 years). Elements of the recommended prioritized vessel capabilities should be provided in sufficient detail to enable NSF to make subsequent appropriate adjustments in response to available funding."
5. "Include a summary of the outreach efforts and input received from the science community in the final, submitted report."

Currently, the subcommittee is assessing existing documents. These include:

i. 2018 ASC-provided Vessel Studies Report
ii. UNOLS 2012 Polar Research Vessel Science Mission Requirements report
iii. 2016 NSF-OPP Antarctic Vessels Request for Information

Other documents related to the charge which the committee has located to date:

- "A Strategic Vision for NSF Investments in Antarctic and Southern Ocean Research"
- "Advancing U.S. Polar Research Through the Acquisition of a New Polar Research Icebreaker, a Report from the Antarctic Research Vessel Oversight Committee June 2006"
- Various older US Antarctic Program documents of potential interest to the subcommittee
- (https://www.nsf.gov/geo/opp/usap_special_review/infrastructure_logistics.jsp)
- A vetted packet of "build specification" documents related to the new British Antarctic Survey (BAS).
- A Leidos "Research Vessel Replacement Report"
- A NSF Major Research Equipment and Facilities Construction (MREFC) document from

2011 relating to a polar research vessel (redacted copy).

Dr. Weingartner said the subcommittee is preparing a questionnaire to solicit advice and comments from the scientific community. The next couple meetings will focus on preparing to obtain community input on future Antarctic polar marine science and the ship resources required.

The subcommittee is taking a two-pronged approach to the task:

- Assemble lists of names and email addresses to reach. Presently thinking of sending to all participants-at-sea on Gould and Palmer cruises.
- Work out the questions we wish to ask the community.

He listed examples of information to be obtained as:

- Are there key science drivers coming into prominence – or anticipated to come into prominence – that should be taken into account in future ship support for US Antarctic marine science?
- Based on experience on USAP and other ships, with what realistic differences in design and outfitting could the Palmer and Gould have better supported US Antarctic marine science?

Dr. Weingartner asked the AC-OPP for suggestions, including whether there are any other documents the subcommittee should examine or any other persons or organizations it should contact.

Dr. Swift raised the issue of how to evaluate the operating model. One of the subcommittee's charges was to consider the two-ship operational model and the advantages and disadvantages of a one-ship model. He asked if the focus should only be on the advantages and disadvantages each operational model brings to support of science, or should other impacts be considered. Dr. Brachfeld said her preference is to stick to science drivers for considering any model, as opposed to political or financial factors. Dr. Manahan said much of what the Gould did was support Palmer, which is indirect science support but massively important. With a one-ship model, that ship might spend 80 percent of its days supporting the Palmer.

Mr. McGovern responded that there is a need for science support both in the Ross Sea region and the peninsula region and so would need to examine opportunities to resupply Palmer in another manner. But he asked how to manage the science out of Palmer Station if doing science in the Ross Sea in the interval.

Dr. Falkner said it was important to be careful to not lock ourselves into the ways we have always done things. The committee's creativity is being sought and asked how sustainable it is to have two-ship operations going forward. It is a severe challenge and the group needs to think in a holistic picture about what we are doing in the regions and how we should best accomplish that. The subcommittee doesn't want to prejudice the AC's thinking, but they have information that may be useful in understanding the options.

Mr. McGovern said the subcommittee received the 2016 Request for Information (RFI), which identified the anticipated budget for ship operations for the foreseeable future. The subcommittee received reports back from Glosten and ASC that include construction and cost estimates for operating two ships. He said there is a sizable difference and mentioned de-

scoping ship capability, reexamining how we operate, or taking a massive bite from the rest of the OPP budget.

Dr. Swift said the subcommittee is in a very early stage, still reading material, and so cannot provide more detail on what members are thinking.

Dr. Manahan said he toured the Palmer and was impressed by how well preserved it is. He asked if continuation is off the table. Mr. McGovern said the Palmer is approaching 30 years old, which is the nominal lifespan. A recent assessment found it has a reasonable amount of life left, perhaps 10 years. The Gould is 6 to 7 years younger and at about 22 years is approaching its nominal end of service. We could wait, he said, but noted the ships are not close to being compliant with the International Maritime Organization's polar code, which became effective last year. In terms of being flagship research vessels representing the United States, they are getting long in the tooth. Whether acting now or in 10 years, the issue remains the same.

Dr. Brachfeld asked if there was potential to partner with Chile or Argentina. Mr. McGovern answered affirmatively. When the British went from 2.5 ships to one ship, they came to the U.S. for help and we have the same question to them. There are a few commercial entities out of Chile offering resupply or refuel support. With two ships, we are our own search and rescue and medivac and can control what is going on with our program. Depending on others requires a high degree of confidence. That exists with some and there is an effort to develop it with others. Dr. Brachfeld responded that in the early to mid-2000s many OPP marine communities had a workshop on this topic with a similar exercise of polling the community and asking them to think 20 years out about the big ideas to pursue and the needed shipboard capabilities.

Mr. Arnaudo asked about the state of long-term planning. He recalled a budget prediction for funding a big ice breaker within the next 10 years.

Mr. McGovern said there has been work by USCG on development of its new heavy ice breaker requirements. It is a challenge of controlling the asset and identifying what we want the ship to do. A heavy icebreaker that is a state-of-the-art research vessel is feasible. But he asked how it will be operated and if by the USCG. Their firm model is 180 days away from home port in Seattle. Seattle to McMurdo Station is a 30-day transit, if going direct, which is not how they do business. It is also very expensive to move a heavy icebreaker at the same time you want to be doing science and break into the McMurdo channel. NSF's perspective is advocating for USCG to have a heavy icebreaker, but they should not be research vessels. When research is needed where it calls for a heavy icebreaker, it needs to be paired with a state-of-the-art research vessel. The Palmer operates 250 days but is in heavy ice 30-40 days. There are different types of ice breakers; the Palmer is one and the POLAR STAR another type.

Dr. Falkner said the USCG received $150 million for final design and has put out a construction Request for Proposals (RFP). The president's FY19 request has $750 million for what the USCG hopes is the first of multiple icebreakers, but it will depend on the appropriation. We are trying to be helpful as possible as they get a very efficient icebreaker that is designed for icebreaking. They have military spec requirements that add to the cost and is well outside what the research community needs. The USCG is committed to meeting the breakout mission in McMurdo and would like an active presence in the Arctic.

Dr. Swift thanked the AC for its comments, which will be conveyed at the subcommittee's next

meeting.

Dr. Brachfeld asked if any of the other UNOLS vessels can operate in the Southern Ocean. Mr. McGovern said the global-class ships operate to the ice edge. The SIKULIAQ is ice and heavy weather capable but there are no plans for it to operate in the Antarctic region; it was built more for Artic use and the Bering Sea. In 2019 the Thompson will be going from Cape Town to the Antarctic. Mr. McGovern added that as the number of UNOLS global class vessels declines, the Office of Naval Research is not anticipating building new global class ships. With this decline, the Palmer has had more work from Ocean Sciences (OCE) supporting Southern Ocean and some polar work as a cost savings to avoid sending a ship from the Northern Hemisphere.

Dr. Stearns addressed community engagement, asking the subcommittee to cast a wider net to include new investigators. Another suggested group was U.S. SCAR. Dr. Falkner also noted the June POLAR2018 Conference.

<u>POLAR STAR and HEALY</u>

Mr. Sheppard turned to the heavy icebreaker (IB) outlook for the next decade. The recurrent opinion is that the heavy IB need is the Achille's heel for sustained McMurdo and South Pole operations and that resupply is uncertain without the heavy IB. They are relying on the POLAR STAR, a 1976-era vessel. It uses brute force to bust through up to 20 feet of ice, which is the current requirement. In the 2002 era two heavy IBs were needed for the break-in. There is now one functional IB, which has suffered sequential mechanical failures. This was a light year for ice, with a 15-20-mile break-in without severe conditions. The prior year an unprecedented 70-mile break-in was needed. The variation makes risk assessment difficult. Contingency planning includes risk mitigation with a loose agreement with China for the XUE LONG and possibly with South Korea for the ARAON for backup with the Palmer, if in the vicinity, in case the POLAR STAR had a catastrophic failure. The current approach is to try to negotiate a retainer agreement for backup with a foreign flagged heavy IB. An RFI will be released soon. The USCG estimates the first heavy IB could be ready by the 2025 season at McMurdo. The Star by then will be close to 50 years old. The USCG approach is to commit the POLAR STAR only to the McMurdo break-in and maintain it aggressively off season in dry dock in Seattle or elsewhere so it is ready for crews on 1 December. The USCG is committing speculatively about $150 million to keep that pace and do engineering reviews. They have given reassurance as best they can that they will deliver a ship but have admitted it may not get past Hawaii. So, a fallback plan is needed. If POLAR STAR was not able to function, it would be approximately 30 days for another heavy IB to arrive. The goal is to be ready with a multi-year agreement with another heavy IB when AIMS takes place and there is a risk of not being able to fully execute the science program at McMurdo and South Pole as well as not being able to execute the AIMS construction timeline.

Discussion

Mr. Arnaudo said the government has been negligent for not replacing the POLAR STAR earlier. He said there was not enough support to get the money out of Congress. He asked if there is anything the AC can do. He suggested including strong support for funding IB development in the committee's recommendations.

Dr. Manahan said he agreed and was shocked that they were holding on by their fingernails. He

said the POLAR STAR frequently broke down, but it had an incredible crew that kept going. He called the situation mind-blowing and said the committee should discuss what it can do to help.

Dr. Falkner referred to FY 2019 funding and said she thought some juggernauts have been passed by. The Navy and the USCG are speaking with one voice on the subject now, after having been at odds, which had made it difficult for Congress to move forward. The Navy and USCG have set up a joint design office and are now reinforcing each other in their budget requests on this topic. But she said it is a very old problem and every season bore watching as the situation unfolds.

In response to a question from Dr. Easterling on what was behind the problem, Dr. Falkner said it came down to each ship costing $1 billion. Mr. Arnaudo added that the problem was also that the USCG is leading it, not the Department of Defense.

Dr. Falkner noted NSF and the USCG are in lockstep. NSF is not trying to get in their way to recapitalize an efficient IB that is designed for breaking. There had been a conflict over vessel requirements. To make it a state-of-the-art science vessel and an IB, it went over $1 billion. When they solicited cost estimates they dialed way back on science requirements that NOAA and others had put on it. NSF had already backed off, recognizing that would escalate the cost and compromise its ability to be an efficient IB.

In response to a question about the original inflation-adjusted cost of the POLAR STAR, Mr. Arnaudo said he didn't have that information, adding that the ship was not a very good science platform. It would help if there was good shipbuilding state with a senator who was pushing for construction. Dr. Falkner said industry interest is high, though shipyards have the challenge of standing up to a task not undertaken in more than4 decades.

Mr. Fleener said there is a problem with NSF or research entities partnering with the USCG. From the Alaska perspective the USCG has been good at forging relationships with the Russian coast guard. Now the perspective is to want cruise missiles on the next IB, which is going to be a serious problem if looking at research as a diplomatic tool. While work with USCG may be the only option, NSF should not close the door to other options. He added that the $1 billion cost is not a problem for a military expenditure for a naval vessel. The problem is maintaining the vessel, including staffing and day-to-day maintenance costs. The USCG was afraid that $1 billion would be allocated, which would be about a third of its budget. Staffing and maintenance costs were not being accounted for in the talk out of Alaska.

Mr. Fleener asked if any analysis had been done on the cost of using submarine IBs, which the Russians are doing. NSF and other research entities have a solid need for research submarines. Those in the know talk about new ways of breaking the ice other than back and ram. Mr. Sheppard said he thought a submarine probably would not be able to do an escort and break through 20 feet of ice, but he was not aware of an analysis.

Dr. Falkner said she was once involved in the White Submarine Concept to refurbish one of the Sturgeon class submarines for civilian use. With help from the Navy, reports were issued with the conclusion that the expense of crewing and maintaining a nuclear submarine was well beyond the current science budgets and there wasn't a need in the Navy. There is science of

opportunity aboard submarines through the Scientific Ice Expedition (SCICEX) program. She suggested putting this on the agenda for a future meeting to check the effectiveness of that partnership. Good science can be accomplished, but it is not clear the community is taking full advantage. Mr. Fleener said the discussion might also cover the feasibility of submarine IBs.

Dr. Brachfeld suggested that opposition to funding might be related to the POLAR STAR being a large expense for something with one mission for a few days per year.

Mr. McGovern said the USCG's ice fleet is not a career path to Admiral, which he said is a big hurdle that limits the attractiveness of working on those ships. Dr. Falkner responded that the information on that was mixed. Looking at the trajectories of those who make it to the top ranks, most have had some IB experience, though the incoming USCG commandant has none. Vice Admiral Charles Ray, who will be Vice Commandant, has IB experience.

Arctic Research Program and Vessel Portfolio

Dr. Rack discussed the distribution of 2018 cruises NSF is supporting, which is a combination of projects on the SIKULIAQ and HEALY, in addition to international platforms. There is a large demand for ships in August and September, requiring multiple platforms and international collaboration. In 2019 to 2020 there will be a large international expedition, Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC). A German IB (POLARSTERN) will be frozen into the ice and a network of other stations will be instrumented around the central observatory of the ship. The ship and network will drift for a year with the ice. It will require international cooperation, rendezvousing with IBs from different countries, aircraft, and is part of the Year of Polar Prediction for a multidisciplinary, integrated study. The central observatory will be less than 5 kilometers, the distributed network less than 50 kilometers and large-scale linkages of more than 1000 kilometers. There will be a number of ships and helicopters rendezvousing with the POLARSTERN for crew changes and resupply. Each leg of the cruise will be from 1.5 to 3 months. U.S. participation is based on person days and there are proposals already funded and some being evaluated now. The distribution of people and projects will be optimized across the project's six legs and assure the science is being represented in all the areas of the cruise and that the people are getting the required support.

Dr. Falkner and Dr. Lyons thanked everyone for their presentations.

Wrap-Up
Dr. Lyons; Dr. Falkner

The committee developed a list of questions to pose to the NSF Director, Dr. Córdova, during her appearance before the AC-OPP.

Agenda for Fall Meeting

Dr. Falkner began by reviewing Fall agenda items discussed yesterday and today:

- The first item, reviewed by Dr. Backe, was the strategic planning document. A first draft will be completed by June 1, he said. It will be distributed for suggestions. Dr. Lyons said AC-OPP should link its timing with AC-GEO. He suggested talking in October about whether some AC-OPP members would present the document at AGU.
- Dr. Weingartner said his group will provide an update at the Fall meeting on polar research vessels and icebreakers.
- Dr. Falkner said Mr. Kosseff will make a presentation with others on safety.
- An update will be provided on the Thwaites Glacier.
- The *Arctic Horizons* report will be provided to the committee.
- Dr. Dixon suggested a meeting with another advisory committee. Dr. Falkner mentioned the logistics of coordinating committee schedules but said she will try to arrange that.

The date for the Fall meeting has not yet been set but will be shortly. Dr. Falkner concluded by saying she will be working with her staff to identify other agenda items.

Departing Committee Members

Dr. Falkner said nine members will be rotating off the committee and she asked for thoughts from them.

Dr. Brachfeld expressed her thanks for Dr. Falkner's invitation to serve on AC-OPP. She said it was a tremendous learning experience. She said one thing she learned was the importance of attending meetings in person vs. being on phone, when she was not fully engaged in the conversation.

Dr. Falkner added that those rotating off have experienced the transition from being on the subcommittee to the full committee. She recognized their contribution and said it made for a more seamless transition.

Dr. Cassano echoed Dr. Brachfeld's comments and thanked the committee for the opportunity to serve. He said it was a learning experience and that attending in person makes a big difference.

Dr. Falkner said the committee must submit a balance plan that describes the factors considered as it balances the committee. She said one element is expertise, which will need to be updated regarding where coverage is needed. The committee also balances for geographic distribution, demographic balance, gender balance, and diversity in many ways. In that light, she asked department members to provide the names of people they would recommend.

Dr. Dixon said he received more knowledge from the committee than he's been able to contribute. He noted the interdisciplinary character of AC-OPP and AC-GEO. He added that it was important not to forget about the people. As an archeologist he said he gets the interdisciplinary character. It is important for members to have a holistic understanding and value the work done in other disciplines. He also thanked everyone for the opportunity.

Dr. Manahan said he had been on the committee about a decade ago. He was struck this time by the growth of awareness of polar programs and the inclusion in the 10 Big Ideas. When he

started polar science 30 years ago it was somewhat of a backwater science and there has been a stunning transition, including the interaction of the Engineering Directorate. The momentum going forward for the committee is exciting.

Dr. Mellish said she also was taking more away from the experience than she's given. Having been an NSF researcher for 15 years before moving into administration, it is interesting to see the different sides, including the AC. The research board is having its own advisory panel soon and she can take what she has seen from AC-OPP interactions and apply it there. As an NSF researcher she always had the support of the organization in Alaska and the Antarctic. It did not always feel that way when the funding was from other organizations and she commended NSF for strongly supporting its scientists. It is nice to be part of a group that can give feedback to help make the Principal Investigator (PI) experience better, though the PIs don't necessarily realize the bigger picture of how much input the AC takes when making larger decisions.

Dr. Neumann added a suggestion for a splinter meeting for new committee members to bring them up to speed and inform them of the expectations. It took him a few meetings to understand the AC's role. He also said he had taken away more than he contributed.

Dr. Stearns said she was sad to be rotating off and to have missed the meetings because of a new baby and school finals. She was impressed by the breadth of issues the AC has addressed and echoed Dr. Mellish's comment about support for PIs. She also commended the committee for addressing the sexual harassment issue and was proud NSF was taking it seriously.

Dr. Welker thanked the committee for the opportunity to be part of the AC. He said it had been insightful and a great experience and he looked forward to contributing to NSF's Arctic mission in other ways. He will be serving on AC-GEO.

Dr. Falkner listed the other AC-OPP members who are on AC-GEO: Dr. Welker, Dr. Fuentes, and Dr. Lynch.

Dr. Falkner added that Dr. Manahan was meant to serve a 3-year term, explaining a comment she had made that it was unfortunate he was leaving. And she commended those who are staying longer because of the transitional period. She also expressed her appreciation for everyone's participation. Following up on Dr. Neumann's suggestion, she said the committee would examine how it can better bring new members up to speed. She again solicited input on new members. She introduced the final member to be leaving, Dr. Lyons, saying he leaves big shoes to be filled.

Dr. Lyons thanked Dr. Falkner and her senior staff for having enough faith in him to have him chair the committee for four years, including AC-GEO. He recalled his first Antarctic and NSF experience, which he said changed his life. He added that every organization has to have good people. Before joining the AC-OPP he had aspirations to possibly be an NSF employee. Then he found out how hard they work and how much responsibility they have. He commended the program officers and the staff. Their role in helping to lead American science is really significant. Most grantees do not appreciate the nuts and bolts that go into running NSF effectively. He complemented OPP and GEO staff and program managers. He also enjoyed

working with the young people on AC-OPP and AC-GEO and realizing U.S. science is in the greatest hands.

Dr. Falkner summarized the agenda items for the Fall meeting:

- The strategic planning document.
- The subcommittee on ships will provide a briefing.
- Discussion of safety.
- Update on Thwaites and possibly MOSAIC
- The *Arctic Horizons* report on social science and the arctic will be distributed.
- A meeting with another AC will be arranged, if possible.
- How to assure the new generation of researchers has leadership qualities and is diverse, including indigenous Alaskans.

Also:

- Dr. Backe will work with members to find an optimal Fall meeting time.

Meeting with NSF Director and Chief Operating Officer
Dr. Córdova; Dr. Joan Ferrini-Mundy; Mr. Brian Stone, Chief of Staff

Dr. Falkner welcomed Dr. Córdova, Dr. Ferrini-Mundy and Mr. Stone and briefly reviewed some of the committee's discussions. After AC-OPP members introduced themselves, Dr. Lyons asked if the director would like to make a statement.

Dr. Córdova thanked everyone for the time they give to NSF and provided some updates. NSF works closely with The White House's Office of Science and Technology Policy and they are starting an ocean initiative and will convene the heads of agencies next week. The initiative is based on the idea the U.S. could lose leadership if it doesn't state its position on ocean science and technology. She also mentioned a celebration of Nobel prize winners she attended and her conversation with Mr. Norm Augustine about his trip to Antarctica, which resulted in the blue-ribbon commission on Antarctic infrastructure. He was very pleased when she briefed him on NSF's current efforts in that regard.

She also reported on a summit held by The National Institute of Standards and Technology (NIST) and the White House on accelerating research to benefit the economy. NSF came out looking good because of the programs it has developed. The foundation's investment in translating research to the marketplace started in the early 1970s and NSF was the first agency to do the Small Business Innovation Research (SBIR) program, which started with the vision of one program officer. The first cohort NSF funded included Symantec and later Qualcomm. It was adopted, along with NSF's Innovation Corps Program (I-Corps), by all the other Federal agencies. NSF has had a leadership role in technology transfer. One session included university representatives who talked about students' changing interests. Many parents lament that their children became capitalists not scientists. But universities are changing and their tech transfer engines have revved up and it's a new day in thinking about how to accelerate NSF's research for benefits to the nation, including prosperity, health, security, and education. Dr. Córdova also thanked the members attending their last AC-OPP meeting.

Dr. Lyons turned to questions for Dr. Córdova. The first was from Mr. Kosseff, who said AC-OPP had discussed sexual harassment issues, especially in remote workplaces, and had received an update on NSF policies. The committee feels that is an important issue and appreciates the director's leadership in moving that issue forward so rapidly.

Dr. Córdova said Dr. Falkner and Dr. Ferrini-Mundy have been very involved in moving it forward. NSF did not stop with the announcement in the *Federal Register*, which has brought helpful recommendations. There are meetings every couple of months and NSF is continually trying to make more progress on the issue. She said that of all the insights she's received in the past year, this area has been the most profound. Being a woman in science and being of her age, she has been conscious of that attritioning population. The dearth of women in science and engineering has been attributed to various reasons and she was not sure why it did not occur to her that harassment could be one of most profound reasons why. When listening to women's comments and how it changed their lives, ambitions, and directions, she thought the implicit bias that has hurt the population of certain sectors of our population could be one of the big reasons why people do not sustain in careers that do not have many people like them.

Dr. Dixon said the committee was delighted with the 2018 budget and asked the director to share her perspectives on how she made that happen. Dr. Córdova said many people worked hard on the effort, acknowledging she spends a lot of time on budgets. NSF has a lot of friends on the Hill, but NSF has to always tell its story better. NSF has traditionally been modest, deferring praise to PIs, who do the work. What's lost is people's knowledge of how the research delivery cycle works. To make the discoveries there has to be funding, which comes from Congress and Congress listens to us putting forward the stories of why it is important and for the return on investment. NSF has been trying to work harder on its story. The website uses social media and videos and NSF attends Awesome Con, for example, as part of its effort to get the word out about what NSF has done. At the NIST event, almost every speaker referred to NSF as the seed of their discovery. She stressed getting NSF's story out to members of Congress when senators and representatives visit AC members' universities, citing NSF as the source of funding. Working on that contributed to the budget increase.

Dr. Welker, speaking by phone from Alaska, invited the Director to again visit the state. He asked for the Director's perspective on the Arctic Science Ministerial in Berlin in the Fall and if the AC can assist in planning and possible implementation. Dr. Córdova said the U.S. Arctic Research Commission chairwoman, Hon. Fran Ulmer, invited her to the commission's meeting in Alaska. A statement has been prepared for the Ministerial that has yet to receive White House approval. Dr. Falkner said OPP would be happy to take the advice Dr. Welker offered on behalf of the AC. Mr. Stone said the White House asked NSF to staff the Ministerial. NSF can use the international agenda to shape the U.S. agenda, he said.

Dr. Brachfeld asked about NSF mechanisms to train scientists to be leaders and ambassadors, in addition to being researchers. The AC has been discussing training for students in postdocs, not only in science but in management and logistics of implementing the Big Ideas and reaching out to indigenous and local communities to inspire the next generation of scientists from underrepresented groups. Those are different skill sets from being a researcher. She asked for the director's thoughts on incorporating those kinds of development opportunities into NSF

programs. Dr. Córdova mentioned a National Academies committee Dr. Alan Leshner is chairing that will issue a report in May (*Graduate STEM Education for the 21st Century*). She mentioned meeting with graduate research fellows and said NSF has expanded the program to include an international and industry opportunity. At one meeting with fellows she asked them about what other training they would like to receive. They answered that they wanted to learn the skills to be the director of a 200-person laboratory. Dr. Córdova said sometimes immersion is the best school. Dr. Ferrini-Mundy, who previously was head of NSF's Directorate for Education and Human Resources (EHR), said it would be important to look at the National Academies' May report. The original charge included looking at the various careers graduate students will pursue outside academia. She expected recommendations about preparation for the "T-shaped individual," which includes many skills in addition to depth in a discipline. The NSF Research Traineeship Program funds innovations in graduate education. Part of it invites universities to experiment with the experiences provided to graduate students. Interesting ideas are arising regarding communication, policy, management, and studying the impact of the offerings. This is the Innovations in Graduate Education (IGE) Track of the National Science Foundation Research Traineeship (NRT) Program. In addition to Graduate Research Fellowship (GRF) students, research assistants are also seeking a broader professional preparation. They have asked if NSF will help with the requirement of having an Individual Development Plan (IDP) for graduate students.

Dr. Easterling said he visited Scripps Institution of Oceanography, where he met with graduate students on NSF support. When he asked how many were interested in the engagement and policy implications of their science, the large majority raised their hands. This is a trend with graduate students, who are interested in more than their traditional discipline.

Dr. Weingartner said the AC had met with other ACs and discussed overlapping interests in the Big Ideas and NNA. He asked the director what changes are needed at NSF, internally or to work with other domestic and international agencies. He also asked about the balance between supporting research toward the Big Ideas and proposal-driven science. Dr. Córdova responded that the Big Ideas were not meant to replace NSF's core investigations driven by curious individuals pursuing special areas of science. They were meant to take a top-down meets bottoms-up approach to meet a few areas of national interest and areas where the U.S. should be first among nations in cooperation with other agencies. In the last 24 hours she spoke with two undersecretaries and one secretary about interest in quantum research. She said the nation may be ready for a national initiative. The current state of knowledge is equivalent to where computer and information sciences was in 1940. NSF is working with other agencies on the Big Ideas and it has to be a collective mindset. She mentioned Inclusion across the Nation of Communities of Learners of Underrepresented Discoverers in Engineering and Science (INCLUDES), saying there was a long way to go, and Growing Convergence Research at NSF. Regarding Mid-scaleResearch Infrastructure, she said there is some amazing research that can be done for a few million dollars to $100 million. There has been no way to get that funding but said that might be changing with the new money received from Congress. She also talked about NSF 2026 and said the public will be invited this summer to contribute their own big ideas. It will bring in new ideas and generate public interest. The driver is promoting the U.S. as leading in areas like artificial intelligence; quantum research; and understanding climate changes in the Arctic, which is a bellwether for the planet.

Dr. Manahan asked about NSF's move to its building in relation to the prevalent idea that problems can be solved by improving communication with a new building. He asked if NSF's new headquarters is helping break down barriers and allowing more convergence. Dr. Córdova echoed Dr. Manahan's comment that it is a very nice building. The building's newer aspects include information technology, which should allow people located anywhere to communicate transparently. Some new buildings have no walls, which invites collaboration, with private meetings in glass booths. In not having that, NSF probably lost an opportunity. Also, the foundation encouraged space wars, with people vying for larger spaces based on General Schedule (GS) classification. It would have been helpful to think about space differently because having offices with walls may not be conducive to convergence. But she mentioned the large meeting rooms and the many vertical and horizontal meetings where people are stirred up and providing their ideas. NSF is doing the best it can with the building.

Mr. Arnaudo thanked Dr. Córdova and Dr. Falkner. He said the AC discussed research platforms on the waters around the ice and the IB fleet, along with new research vessel plans and asked for the director's thoughts on the state of the research vessel platform. Dr. Córdova said there is a huge fleet of UNOLS vessels; Dr. Falkner added that OPP is actively engaged with UNOLS and asked Dr. Weingartner to provide background information to the director. He said a subcommittee had been formed to address the status of the two research vessels and review recent reports and studies and recommend any changes. A big issue is whether to switch to a one-vessel fleet or maintain two. The review will be completed in the Fall and referred out to the science community for recommendations.

Dr. Córdova noted that ships do not last forever and need to be replaced with cheaper, faster ones with more capability. It takes a lot of time to launch construction of a ship and get Congress on board with the need. There is a common view that one ship is like another, she said. It is never too soon to start the conversation of why ships are built to be appropriate for their missions, where they need to be, the science they do, the logistics in Antarctica and the Arctic, and that ships age and need to be replaced with ones that do the science better. Once that is established it still takes many cycles, she said, citing the struggle with the three regional class research vessels that was approved in the FY '18 budget. The money is not yet available for the third vessel. You have to be in the process all the way through with continuous leadership that keeps making the case. There are a lot of builder communities that can be brought on board because of job opportunities, which Congress likes. There is also the opportunity to invite members of Congress on board. She concluded by saying it is a big endeavor requiring much long-term planning.

Dr. Lyons thanked the director for her time and thanked Dr. Ferrini-Mundy and Mr. Stone for attending.

Dr. Córdova said Dr. Ferrini-Mundy will be leaving NSF to become president of the University of Maine. The director thanked the AC for everything they do for OPP and said the advisory group will make a difference with polar sciences.

Closing Business

Dr. Weingartner suggested reestablishing the OPP postdoctoral fellowship program. The transition between finishing a Ph.D. and staying in science is a very important time, he said, and having this specific program for the Arctic and Antarctic is very important. Dr. Lyons said the suggestion would be passed on to the next committee chair.

Dr. Falkner said that at the next meeting those on the phone would have to use their webcams so they can be seen in the meeting when they speak.

Mr. Arnaudo asked how vacancies on the committee are filled. Dr. Falkner, noting Mr. Arnaudo had to be out of the room earlier, said she relies on receiving good advice from outgoing AC members, as well as others on the committee. Dr. Backe will collect the suggestions. There is a complicated matrix that is used to achieve a balanced membership. There is also an annual request to the public for membership suggestions that is in the *Federal Register*.

The meeting was adjourned.