Advisory Committee for Geosciences
April 8-9, 2015
Meeting Minutes

**AC GEO Attendees:**

Dr. George M. Hornberger (Chair)
Ms. Vicki Arroyo
Dr. Mary C. Barth
Dr. Paul Bierman
Dr. Catherine Constable
Dr. E. James Dixon
Dr. Scott C. Doney
Dr. Rana Fine
Dr. Kip. Hodges
Dr. Pamela Kempton
Dr. W. Berry Lyons
Dr. Joshua Semeter
Dr. Julienne Stroeve
Dr. Gregory Sullivan
Dr. Brian Taylor
Mr. David H. Voorhees
Dr. Joseph A. Whittaker

**Absent AC GEO Members:**

Dr. Mary-Elena Carr (on phone on second day)
Dr. Kim Prather

**NSF Senior Staff:**

Roger Wakimoto, Assistant Director, GEO
Margaret Cavanaugh, Deputy Assistant Director, GEO
Paul Shepson, Division Director, AGS/GEO
Carol Frost, Division Director, EAR/GEO
Richard Murray, Division Director, OCE/GEO
Kelly Falkner, Division Director, PLR/GEO
Melissa Lane, Executive Secretary, AC GEO

**Wednesday, April 9, 2015**

**Welcome & Introductory Remarks**

Dr. Hornberger opened the meeting and welcomed the group and members introduced themselves.

**Update on NSF GEO Activities**

Remarks from the Assistant Director for Geosciences. Dr. Wakimoto welcomed the Advisory Committee members, in particular the many new members, and discussed the agenda for the two-day meeting.

He started his presentation with selected updates, beginning with a review of *Sea Change: 2015-2025 Decadal Survey of Ocean Sciences*. He discussed the balance between infrastructure and core research programs and said the study was commissioned to do a portfolio review of the facilities in light-high priority science questions under a constrained budget. This is the first such study for the geosciences and ocean sciences. Dr. Wakimoto said he could not provide the NSF responses to the study until it is approved by the National Science Board, which is expected to occur in May. The report encompasses eight broad scientific questions and includes a portfolio review for the University National Oceanographic Laboratory System (UNOLS), the International Ocean Discovery Program (IODP) and the Ocean observatories Initiative (OOI). The report has had a record number of downloads.

Released in December 2014, the report articulates geo-wide priorities. It states that the highest priority is a continued strong emphasis on support of core research. It also emphasizes the importance of collaborative efforts to improve understanding of and resilience to hazards and extreme natural events. A third is establishing a collaborative effort to understand the water cycle.

Dr. Wakimoto emphasized the report’s recommendations for maintaining state of the art facilities, completing construction and beginning full-scale operation of the OOI, implementing strategic plans for logistics and operations for the Polar Regions and beginning conceptualization and development of next-generation Sun-Earth-system community models.

He highlighted how GEO was factored into the FY 2016 budget. He listed the four NSF-wide priorities:

* understanding the brain;
* broadening participation,
* risk and resilience;
* Innovation at the Nexus of Food, Energy and Water Systems (INFEWS).

GEO is co-lead with Engineering for the latter two, which are new science initiatives.

GEO’s part of Risk and Resilience is Prediction of and Resilience Against Extreme Events (PREEVENTS), which is budgeted at $23.5 million for 2016. INFEWS is funded at $14.78 million. The budget also includes $24 million for Science, Engineering, and Education for Sustainability (SEES), $25 million less than FY 2015 for this initiative, which is being ramped down.

PREEVENTS is designed to:

* enhance understanding of fundamental processes underlying geohazards and extreme events on various spatial and temporal scales;
* improve models of geohazards, extreme events, and their impacts on natural, social, and economic systems;
* and develop new tools to enhance societal preparedness and resilience against such impacts.

To underscore the financial impact from extreme events. Dr. Wakimoto presented graphics illustrating U.S. insured loses from catastrophic events that occurred between 1994 and 2013. Hurricanes and tropical storms accounted for the largest percentage (39.9 percent, $159.1 billion) and tornadoes the second largest (37.2 percent, $148.3 billion). The graphics also illustrated what Dr. Wakimoto called a slow and steady march upward in the number of catastrophic events.

Reviewing INFEWS, he said it was intended to support integrated research and modeling towards creating a comprehensive food-energy-water socio-technical systems model; and advance knowledge and technologies that foster more safe, secure and efficient use of resources within the food-energy-water nexus. INFEWS is the successor to SEES Water Sustainability and Climate (WAC). Dr. Wakimoto noted there will be a dramatic increase in demand for food, energy and water in the coming decades.

To illustrate NSF’s implementation of the *Sea Change* priorities, support for core research will be increased by $25 million in FY 2016 (offset by a reduction in SEES). Also, PREEVENTS is the result of following through on the plan to improve understanding of and resilience to hazards and extreme events. INFEWS illustrates the emphasis on the water cycle and Antarctic Infrastructure Modernization for Scientists (AIMS) is the implementation of the priority put on logistics and operations in the polar regions.

Moving on to the NSF budget request for research and related activities (R&RA), Dr. Wakimoto noted that Geosciences was the only directorate held level between 2014 and 2015. But the 2016 request is up 4.7 percent, slightly more than the total for R&RA and makes up for the level budget received in 2015. Discussing the budget request by division, he noted that Integrative and Collaborative Education and Research (ICER), which increased 13.7 percent over the 2015 estimate. He explained the increase by noting that in the 2016 request, a line item was created for mid-size infrastructure ($9.31 million). It will serve all of GEO, though it appears in the ICER account.

GEO began encountering significant challenges in April 2013 with the release of a report from The Information Technology & Innovation Foundation (ITIF) entitled, *25 Recommendations for the Reauthorization of the 2013* *America COMPETES Act*. Dr. Wakimoto cited what he called its “disturbing” recommendation for, “a reallocation of NSF resources toward the kinds of science that has direct economic and industrial benefits for the United States. In particular, this means increasing NSF budgets for four key directorates: 1) math and physical sciences; 2) engineering; 3) computer and information sciences and engineering (CISE); and 4) biological sciences, *while permitting research budgets for the geosciences and social sciences to shrink*” (emphasis added).

He said the report has received a lot of traction, with the quoted statement appearing in the House Science Committee authorization bill. Continuing on the theme of challenges to GEO, Dr. Wakimoto cited a March 2015 article from *Science Insider* headlined, “Earth science is not hard science, congressional Republicans declare.” He said it was surprising this position was endorsed by the newly elected U.S. Senator from Colorado, since that state has more scientists than almost any other place in the country. But he also quoted a Connecticut Congresswoman who recommended full funding “for NSF’s Risk and Resilience initiative... .”

Regarding publications, Dr. Wakimoto noted that NSF released the public access update for publications. NSF will require manuscripts in peer-reviewed scholarly journals and papers in juried conference proceedings or transactions to be:

1. Be deposited in a public access compliant repository designated by NSF;
2. Be available for download, reading and analysis free of charge no later than 12 months after initial publication;
3. Possess a minimum set of machine-readable metadata elements in a metadata record to be made available free of charge;
4. Be managed to ensure long-term preservation; and
5. Be reported in annual and final reports during the period of the award with a persistent identifier that provides links to the full text of the publication as well as other metadata elements.

This update will come out in January 2016. The new requirement has been embraced by some, but not all, of the societies that do publications.

A suggestion was made to include this issue for discussion on the agenda for the next meeting.

Regarding data, NSF does not have any upcoming changes to its current data management plan requirement or policies on costs of publication and data citation in biographical sketches, but it is reaching out to the research communities on this issue in support of public access goals. Dr. Wakimoto said the amount of data, including model output, is increasing geometrically with time. The issue also includes non-digital preservation. Discussion has included starting with making data associated with publications easily available.

A important related topic is the reliability and replicability of data. He noted that the Foundation is beginning a wide-ranging discussion of the quality and utility of the results of the research it funds, and invites its stakeholders to join that discussion. Dr. Wakimoto reported that some people in the Geosciences community have said this is less of an issue than it is for other areas, such as clinical trials.

Dr. Wakimoto asked the division directors to provide him with one highlight of their work.

* For Earth Sciences, the highlight is new tracers that can identify fracking fluids in the environment, distinguishing fracking fluids from wastewater coming from other sources.
* For Polar Programs the highlight is the Distributed Biological Observatory, a Change Detection Array that looks at how changes in climate impacts the marine ecosystems. It is part of the artic observing network and provides long-term observations to monitor marine ecosystem responses to physical drivers.
* For Ocean Sciences, the highlight is geotraces and a complete picture of the global ocean chemistry with a 3D composite of dissolved iron in the Atlantic Ocean constructed from seven independent national transects, which a decade would have been impossible to put together.
* Atmospheric Geospace Sciences presented a diagram analyzing the drought in California and its role in climate change. Figures showed the amplitude of a blocking high keeping rain from the area and the importance of the anthropogenic factors. Dr. Wakimoto called it one of the more definitive studies that links the California drought to climate change.

Discussion. Dr. Hornberger went back to the topic of replicability and said NSF is not excited about funding a study to reproduce a result. Dr. Wakimoto added that the Foundation is also not excited about funding something that produces negative results.

Dr. Hodges said he and his colleagues had received negative responses from NSF on proposals because the research had already been done and he said it was a big issue that has been ignored too long in GEO.

Dr. Constable said the reason people think it isn’t a problem in the geosciences is partly because research is not being replicated. There is large financial and competitive pressure to replicate results in the health sciences.

Dr. Wakimoto added that the Engineering Directorate does not think this is an issue. Their view is that if something has been done correctly it will be noticed immediately and there is a strong incentive to assure results are hard, fast, true and replicable.

In response to a question from the committee he said the impetus for examining the issue is partly internal and partly comes from the Office of Management and Budget (OMB). He declined to characterize it as an administrative process and if there are workshops the broad community will be involved, including publishers.

In response to a question from Dr. Constable about GEO’s perspective on the question of large universities and the responsible conduct of research and the need for training in this area, he said this has been discussed across the Foundation, with the Education and Human Resources Directorate having particular interest.

Dr. Falkner raised the issue of the pace of publication and the increasing incidence of data falsification and the international aspect of research, including the question of possible recourse if a colleague from another country does not behave ethically and she referenced a workshop summary that raises these issues.

Dr. Constable asked if the there is an actual increase in fraud, rather than just an increased rate of reports. Ms. Falkner said it was increasing

Dr. Hornberger brought the discussion back to AIMS and NSF's Major Research Equipment and Facilities Construction (MREFC) account and asked for information about the next hurdle and a timeline.

Dr. Wakimoto responded that conceptual design reviews were needed first, which take about a year at each step, after which they are presented to the director who, if she approves, presents it to the board for action. He estimated it would not be till the latter part of the decade that it would become a budget request.

In response to a question about how ICER funding will be distributed, Dr. Wakimoto said that if the budget request is approved, it would involve all the divisions. There has yet to be any discussion about how to integrate input form the community, though he said he expects the divisions would propose possible topics for this category. He added, in response to a question, that many of the divisions previously had a mid-size infrastructure account but because of flat budgets, that is one of the first to be zeroed out. The additional ICER funding is an attempt to reinvigorate that on a directorate-wide basis.

Dr. Taylor noted that *Sea Change* was a GEO directorate and program influenced creation. It was not just the external advisory committee placing a constraint on NSF GEO. Because it was written as much from outside the NSF building as inside, there is a synergy and it is natural for the flow of budgets to follow the document.

Dr. Constable asked about data and cyber infrastructure, which is mentioned as an imperative in the report, and asked about the lack of a timeline for NSF discussions on when people will be obligated to make data available.

Dr. Wakimoto answered that NSF supports making data available, but there is a danger in moving too fast and making the wrong decision. He estimated that if NSF wanted to create a repository for data it would consume the entire Foundation’s budget. To give a sense of the timeline, he said there is a new data committee and it is asking a two-year commitment from its members, with possible renewal after that.

Dr. Kempton offered that experience from the U.K., including the British Geological Survey, suggests the cost of data management will be from 5 percent to 10 percent of budgets.

A member of the audience reminded the committee that there are existing policies in place and that program officers closely examine data management plans and a substantial amount of money is currently being spent on data management.

Dr. Wakimoto responded to a question from Dr. Fine about the America COMPETES Actby noting that he has made several trips to the Hill to talk about the importance of GEO in the 2016 request.

Dr. Taylor followed up on this, suggesting that it is incumbent on the committee to take further action to engage the Congressional process with its own delegations. He said some members are already working hard to make sure there is contravening language introduced on the Senate side to at least force a conference discussion between the House and Senate.

Ms. Arroyo raised the issue of research related to food that is wasted and protecting existing water resources, which Dr. Wakimoto addressed by saying that Social and Behavioral Sciences are part of INFEWS and NSF, which is doing the basic science, is partnering with other agencies to address this issue. As an example, the Department of Agriculture provided funding as part of a NSF solicitation.

Dr. Voorhees said there is a need to get NSF’s message out more effectively. He suggested attacking the problem from the bottom up, educating individual voters who can then contact their government representatives.

Dr. Dixon said that as a museum director he was particularly aware of and stressed the importance of data management as it applies to physical samples.

Dr. Constable said it was not so much that all of science was under attack but that earth sciences had been declared as not a science and lumped with social science, something that was extremely disturbing.

Dr. Semeter said geoscience was being compared to social science because both deal with complexity. He said education is needed to make it clear that predictive models can be created for complex systems such as the climate.

As part of that educational effort, Dr. Hodges said the point needed to be made that geosciences are the great integrative science that includes physics, biology and chemistry. The community needs to be more aggressive in making the point that geosciences is the science of societal survival.

Dr. Shepson discussed the paper by N.S. Diffenbaugh that Dr. Wakimoto referenced earlier on the connection between the California drought and climate change. Dr. Shepson said the focus is the juxtaposition of occasional low precipitation years and warm years and how that connects to impact. From the 1990s, the probability that a low precipitation year coincides with a relatively warm year is nearly 100 percent and the societal impacts of low perception being relatively worse going forward. The point of the paper is the impact on climate change on drought year impacts, which is very significant.

Returning to the discussion of data, Dr. Semeter added that NASA is using Amazon Web Services for Earth science data sets and they are creating tools for the public to access these data.

Dr. Doney said his experience is that a handoff to a third party may be appropriate for archiving, but not for curating and repository building.

In response to a question from Dr. Taylor about EarthCube informing the discussion about data reproducibility and management, Dr. Wakimoto said EarthCube is core to the discussion.

**Update on Merit Review Pilots**

Dr. Steve Meacham, who is a Senior Staff Associate, NSF Office of Integrated Activities (OIA) co-chairs the Merit Review Working Group, which in 2011 was tasked to examine ways to improve the merit review process. He said it analyzed a number of pilot ideas, which parts of NSF have tried out. NSF started launching these pilots in FY 2012. NSF also established a process for trying a pilot and for suggesting modifications.

NSF has 496 Program Officers, who processed 48,051 competitive proposals in FY 2014. Competitive proposals have a success rate of 23 percent, which is greater than the success rate for the 38,882 research proposals (20 percent). There are 35,097 reviewers for proposals, a number that has declined over the past 15 years. Another class of workload is preliminary proposals, of which there were 4,854 in 2013; a percentage of these applicants are invited to submit a full proposal.

Except for 2009, the success rate for proposals has been trending down. In the last few years, as NSF’s annual budget has not been increasing, which has been a factor in the lower success rates. In the first half of the 2000s, there was a significant increase in the number of proposals submitted. That has slowed down in the last few years. The challenge to NSF and the review community is illustrated by increase between 2001 and 2014, when the number of research proposals increased 68 percent. But research funding for this period only increased 32 percent. The increase in proposals also means staff have to more efficiently process applications. The size of research awards, meanwhile, has increased.

Nonetheless, there have been increases in the representation of under-represented groups, with a steady upward trend in proposals from women NSF-wide over the last 14 years and an upward trend in proposals from underrepresented racial or ethnic groups. The percentage of proposals from and awards to PIs with disabilities has declined, but the number of proposals received has significantly increased, so there has been a slight increase in the number of proposals from PIs with disabilities. The proportion of awards to new PIs has remained constant at about 27-28 percent.

Looking at the number of awards and proposals as a function of years since the PI’s Ph.D., there is a steep rise until 6 years past Ph.D. and then gradually fades to 0 with age. Awards increased to about six years past Ph.D., but stay sustained for about another 8 years before declining. The success rate for research proposals increases rapidly to about 4 years after Ph.D., when it is at about 17 percent, and it slowly increases thereafter.

Discussing review methods between 1998 and 2014, Dr. Meacham said the percentage of panel-only reviews steadily increases over this period. Applications sent in by mail or electronically that receive a panel review has dropped only slightly from 30 percent in 1998. Mail only review (ad hoc review only) has declined significantly from less than 30 percent to less than 10 percent. Whereas there were a significant number of people being asked to review two to three proposals per year in 1998, now there is a significant number of people being asked to review a panel’s worth of proposals.

In 2001, 50,684 reviewers handled 30,829 proposals and in 2014 35,097 reviewers handled 46,269 proposals.

In response to a question, Dr. Meacham noted the NSF-wide numbers can be much different from the numbers for specific divisions and programs.

Moving on to merit review pilots, Dr. Meacham began with virtual panels, which involve the use of review panels in which all panelists participate electronically from distributed locations such as homes or offices, instead of meeting face to face. The hoped for potential impacts were broadening participation in the reviewer pool, decreasing reviewer time commitment, increasing flexibility in panel implementation, and cost savings. The starting ideas were that the impacts would depend on the size of virtual panels and the size of panels being replaced; that virtual panels work best for small panels reviewing relatively small numbers of proposals, and that virtual panels were best suited for reviewing proposals that clustered around a common theme.

In FY 2011, 1 percent of paneled proposals were virtual. In FY 2014 that number increased to 15.5 percent.

For 2014 there were 520 virtual, 639 mixed and 662 in-person panels. For virtual panels, there were an average of six panelists per panel, vs. 9 for in-person and they reviewed an average of 15 proposals per panel, vs. twice that number for in-person panels. Thus, virtual panels reduce the workflow and time of the reviewers.

There is limited data to date on virtual panels, but so far they show a small increase in the participation of women NSF wide. But women participate in a much higher rate in hybrid panels than they do in person. Also, the participation of women on panels is higher than their representation as PIs.

Also, virtual panels decrease reviewer time commitment and increase flexibility and the cost reviewed per proposal is reduced. The downsides include a reduction in the opportunity to network; distraction of panels by teaching and administrative work; and technology problems.

Discussing preliminary proposals, Dr. Meacham said these require shorter, simpler proposals and full proposals are only invited from those whose preliminary proposals review well. The potential impacts, which depend on the details of implementation, could include a decrease or increase in reviewer workload; an impact in staff workload; and an increase or decrease in review costs. Preliminary proposals have been implemented by the Divisions of Environmental Biology (DEB) and Integrative Organismal Systems (IOS). Preliminary proposals appear to improve the success rate because the success rate is based only on full proposals. Another effect is a reduction in proposal pressure (the amount of full proposals researchers have to write).

The number of reviewers needed was reduced, though the number of ideas to review has increased by 7.5 percent. Overall, there has been an almost 14 percent reduction in the number of reviewers for a given number of proposals.

The time between submitting an idea and getting funding for it has increased because of the two-stage process.

Another pilot involved e-voting. Panels group proposals into different categories of merit based on the panel discussion. Some panels employ a “straw‐poll” of panelists to get a sense of where the panel is inclined to situate a proposal. One division experimented with e-voting. The pilot used a Web-based voting tool. Potential impacts were reduced time required, increased poll accuracy, and reduced peer pressure.

The pilot was tried by the Division of Astronomical Sciences (AST). They found e-voting increased accuracy, reduced time, and decreased peer pressure. AST is now using e-voting for all of its panels.

In another pilot called One-Plus, reviewers were asked to identify potentially transformative research separate from the likelihood of success. If a proposal was declined the first time, these proposals were provided with a second submission opportunity.

Potential impacts were identified as accelerating support for highly significant, potentially transformative, higher-risk research; reducing burdens on PIs and reviewers; and reducing burden on NSF resources.

This was implemented by Geography and Spatial Sciences (GSS), which found the shift to one round enables GSS to fund 60 percent to 70 percent more proposals in the fall; the Plus round provides an additional opportunity for PIs with especially promising ideas; GSS still actively co-reviews proposals; GSS received very few complaints from prospective PIs; and the spring workload was reduced so program staff have more time to engage community and stay current with science.

Another pilot involved asynchronous reviewer discussion in which a set of reviewers is assigned to a proposal and each submits an independent written review. After submission, a reviewer can see the other written reviews and begin a discussion of the merits of the proposal with the other reviewers on a secure online bulletin board. At the end of the discussion period, the scribe prepares a summary of the discussion. Asynchronous discussions amongst reviewers can be used to augment an ad hoc review, as a different form of panel discussion, and as a precursor to a regular panel.

The potential impacts were identified as adding opportunity for ad hoc reviewers to reconcile contrasting views, helping identify proposals needing more or less discussion during panel, and providing a more thorough review.

The results from nine trials in 2013 were positive, with program officers and panelists finding it made the process more efficient, except for the use of the SharePoint technology. In FY 2015, with a switch from SharePoint to an interactive panel system, the technology was found to be easier to use. However, there was little discussion among panelists until the panel met.

Dr. Meacham discussed the increase in proposal pressure and the desire to meet six-month goals that caused many to switch to panel only review and institute deadlines. This increased proposal pressure. Programs that did not make the switch to proposal deadlines found their funding pressure has not increased as quickly, creating a hypothesis that deadlines were driving proposal pressure. The Infrastructure and Facilities Program tested this hypothesis by eliminating deadlines.

The impact of eliminating deadlines was that proposal pressure dropped by a factor of two. The hope was also that better proposals would be submitted.

Discussion. In response to a question about the last example and how the proposals are organized into panels, Dr. Meacham said it depended on the program. Some, without deadlines, rely on an ad hoc review. The Infrastructure and Facilities Program waits until a sufficient number are received to organize a panel. There is also the opportunity for ad hoc reviews.

In response to a question about whether this is being tried for other than a facilities program, Dr. Meacham said it is also being tried by five research programs.

Another question was asked about e-voting and whether there is an opportunity to discuss the proposals before submitting e-votes. Dr. Meacham said the panel discussed the proposals and then decided where to situate it on a spectrum of highly recommended to not recommended, then voted.

Dr. Meacham responded to a question about NASA’s procedures by saying NSF can make binding invitations for proposal submission or advisory invitations. This is determined by the solicitation and whether an external review is used.

Regarding a question about demographic data for two-year colleges, Dr. Meacham said he did not have the specific information available but that his office has data on the numbers of proposals and reviewers from two-year colleges.

Another committee member asked about allowing the proposers to come back in the cycle to provide commentary back to the panel that the program manager evaluates. Dr. Meacham said there are some programs that include an opportunity for PIs to react to the comments. Most do not because of limited time resources.

**Working Lunch: PLR Subcommittee Meeting (Committee of the Whole)**

Dr. Lyons, who chairs the PLR Subcommittee, recalled that at a previous meeting there was agreement to add expertise from outside the committee as a whole to its subcommittee. Those outside members have been selected and details are available on the Polar Programs website, as are the minutes of the April 3 conference call.

Dr. Falkner reviewed major staffing changes for IT and communications as well as the appointment of a new section head.

She provided a brief budget overview with the requested budget figures, noting that these numbers were flat and had not significantly changed.

Dr. Stone, the section head for Antarctic Infrastructure and Logistics, reviewed the AIMS project. He described AIMS as a comprehensive redevelopment of both McMurdo and Palmer Station, Antarctica, to include the runway, port, logistics, communications and science support facilities. It addresses large-scale issues identified by the 2012 USAP Blue Ribbon Panel that cannot be addressed through normal operating budgets. It includes a capital plan for major facilities and supports the science drivers identified in the 2011 NRC report.

AIMS’ guiding principles are:

* Contain or reduce operational costs and improve efficiency
* Reduce support personnel
* Reduce energy consumption
* Provide a safe and healthy working environment for USAP personnel
* Flexibility to support science in Antarctic for the next 35-50 years
* Reflect the stature and values of the United States of America.

The scope of the AIMS project encompasses:

* Central Services
* Field Science Support
* Fire/Medical/Recreation
* Trades Shop
* Helicopter Operations and Passenger Terminal
* Waste Handling / Recycling
* Hazardous Waste / Fuels
* Dive Center / Sea Ice Support
* Ross Island Earth Station
* McMurdo Airfield Complex
* Utilities Infrastructure
* Bldg 4- IT&C Primary Facility Addition & Remodel
* Traverse Ops/Winter Storage
* Vehicle Maintenance Facility
* Crary Lab
* Lodging
* Palmer Area.

Dr. Stone reviewed the existing McMurdo Station Site Plan, which shows a distributed network of buildings much as it was in 1965. AIMS proposes a much more consolidated footprint. He also reviewed the Palmer Station Site Plan and plans for a new pier, hazardous waste building, power plan and fuel tanks.

Major milestones include:

October 2014 Approval to enter into CDR Phase

March 2015 CDR External Review Completed

May 2015 MREFC Panel Presentation (CDR)

July 2015 Approval to proceed to PDR (notional)

 Design and Engagement period (16 months)

September 2016 Preliminary Design External Review

November 2016 MREFC Panel Presentation (PDR)

February 2017 Earliest possible NSB action

October 2018 Earliest possible appropriation

2019-2027 Major construction timeline.

Dr. Stone also showed drawings of the new McMurdo Station.

Discussion. In response to a question about budget constraints, Dr. Stone said the scope of the project is developed and then the cost, which is the current phase. The affordability of the plan occurs in the next phases.

Another question was raised about whether the construction would disrupt operations. Dr. Stone said one of the implementation constraints is that science programs will not be suspended.

Dr. Falkner noted an NRC report, which pre-dated the blue ribbon panel report, suggesting future science drivers. The NRC report was developed without thought to budget constraints. It was recommended to look at how science is done and changing the science footprint.

Dr. Stone said in response to another question about the place of communications in the plan that those needs were a more immediate problem and efforts were underway to expand bandwidth in the next four years.

To address a question about how to plan for such long time frames, Dr. Stone said complicated cost models developed with the assistance of a business analyst and using a risk-based approach were keys to long range planning.

Regarding sources of electricity, he added there is a newly renovated diesel plant. There is also wind power and there are investigations about increasing the amount of renewable energy.

In response to changing ice conditions and the airfield, Dr. Stone said a new wheeled runway at McMurdo is being developed at a new site to replace one that is usable only during the winter and the late season but not during the summer.

Continuing the PLR presentation, Dr. Eric Saltzman showed a logistics map to provide an overview of some the field work the artic section will be deploying, requiring extensive international partnerships. One aspect of that is a joint U.S.-Sweden research workshop involving the ODEN ice breaker. Projects will look at the Petermann Glacier in 2015 and plans for a 2018 project in the central artic studying the Artic energy budget. Interagency discussions are being held to discuss these and other missions.

Regarding U.S. arctic policy, Dr. Saltzman discussed the National Strategy for the Artic Region (2013), the Implementation Plan for National Strategy (2014), an executive order (2015) enhancing coordination of national efforts in the arctic that established an arctic executive steering committee. Dr. Saltzman said this executive order elevates the visibility and importance to the nation to a higher level than ever before and this will ripple through federal efforts in a number of agencies in coming years. Simultaneously, the U.S. is taking over the Artic Council chairmanship (2015-17) in May. The parts of the U.S. arctic policy that relate to NSF fall into the areas of climate change, environmental stewardship, well being of arctic peoples and international cooperation.

Dr. Saltzman concluded with a discussion of the Interagency Research Policy Committee (IARPC). The NSF director is the chair of IARPC. He said he expects IARPC to remain the scientific arm underpinning the new arctic executive steering committee. He referred the committee to the IARPC collaboration website (iarpccollaborations.org) where the PIs and others can discuss with federal agencies and other domestic and international science partners.

Dr. Falkner noted that IARPC’s current five-year plan was folded into the arctic strategy for the nation. She said there will be a renewal of the interagency arctic research policy five-year plan in about a year and she asked for input for the new plan.

Discussion. The first question was about research related to the cold air from the arctic affecting the eastern U.S. Dr. Saltzman said there was a deep disagreement between those who examine the empirical evidence for what has happened in the years of especially low sea ice with polar air coming down the east coast and the dynamicists who argue that the loss of sea ice is insufficient to account for the effects dynamically.

On the ODEN workshop, Dr. Saltzman said the report would be released in June.

In response to a question about the impact of the Sikuliaq ship on PLR programs, Dr. Saltzman, the program manager for research support and logistics, said the addition of the Sikuliaq to the portfolio of ships is an addition of access for researchers to get to the arctic. It can only work in the arctic certain months of the year. But there are many researchers who want to work in the arctic in August and September. This year it has been the only available ship to enter certain waters. Dr. Falkner said the vessel will be used by other agencies and said it was important to ensure our assets are used in the best way possible for the community.

Ms. Sue LaFratta continued the PLR presentation with a discussion of the physical qualification process required of researchers who deploy to PLR stations. A comprehensive risk-based approach to revising the qualifications began in the last year. Screening tests were revised for breast cancer, cervical cancer, and the exercise stress test, which everyone had to undergo yearly to reduce the risk and cost. Most groups undergo background checks, except for grantees. She sought the committee’s input on what kind of background checks are used at their universities and how can PLR learn what is included in that check and does PLR need to stand up something of its own.

Discussion. Ms. LaFratta clarified that currently contractors and federal employees and military members go through a social security trace, and a criminal background check that covers county, state and federal for a seven-year period. There is also an employment verification and educational verification, but these checks are not done for grantees.

Expanding on the need for this qualification she said it puts the program in better stead to be confident it is addressing the security and safety of everyone who is deployed at its stations, which are remote and have limited law enforcement. If there should be an incident, the program would like to show that it had put measures in place to anticipate such an eventuality.

On the question of what would be disqualifying information, Ms. LaFratta said those rules would have to be developed. The contractor has an algorithm whereby a DUI within the last three years renders the applicant physically unqualified. There has been discussion about changing that time period. She said these standards are yet to be decided.

Dr. Constable said her university does not run background checks on academic staff and only runs background checks when it is necessary for their responsibilities.

Dr. Hornberger said this would vary by university. He said all new employees at Vanderbilt, including academics, undergo a background check.

Ms. LaFratta said there is a mechanism for reviewing foreign students also. This is not done through the visa process, unless they are coming through the U.S.

Another committee member said his university only requires background checks for those working with minors.

Ms. LaFratta mentioned a program called Verified Volunteers, which is used widely by non-profits, to perform background checks.

Dr. Doney said transportation worker identification cards are required for the oceanography community to board ships.

Ms. LaFratta said the new PLR system should leverage such checks that are already being made, rather than duplicate them.

Dr. Taylor raised the issue of vetting foreign nationals with reference to the equipment they have access to and Ms. LaFratta answered that the current contractor makes such an evaluation.

Dr. Constable suggested that as institutions become more risk averse there will be more background checks and recommended a system that is as uniform and trouble free as possible that minimizes the time and effort that the institution has to spend obeying the rules and the PIs have to spend conforming with the requirements.

**EAR Subcommittee Meeting (Committee of the Whole)**

Dr. Frost reported on a March 24 virtual subcommittee meeting. EAR supports basic research and education proposals to advance the Earth sciences. Guiding principles include funding projects recommended based on competitive merit review, awarding funding in topics driven by the community, and assuring access is provided to all qualified investigators.

EAR’s science program directors organized a two-day retreat in February that covered the research program (the evolution of core programs and emerging science topics, cross cutting research and mid-scale science), education and facilities (workforce issues, the post-doc program, facilities and infrastructure, geochronology, the role of national offices in large collaborative projects and the seismic and geodetic facilities re-competition) and theme areas (advancing scientific excellence in Earth Science research, fostering research infrastructure to enable scientific advances, building capacity through geoscience education, excelling as an organization, communicating and engaging with the public and assessing and evaluating programs).

Dr. Frost provided an update on cross-cutting research, focusing on opportunities and challenges for U.S. geochronology. The central role of geochronology and the critical need for geochronology instrumentation and facilities was referenced in the report, *New Research Opportunities in Earth Sciences*. Over the last year a community-led working group gathered input and presented a report to NSF in March (*It’s About Time: Opportunities & Challenges for U.S. Geochronology*) that emphasized the importance of innovative, high-risk R&D, identified ambitious geochronology research goals and recommended a coordinated network of U.S. geochronology laboratories.

Dr. Frost also reviewed the Seismic Facilities Advancing Geoscience and EarthScope (SAGE)/Geodetic Facilities Advancing Geoscience and EarthScope (GAGE) re-competition. In FY 2014 these facilities were reorganized and cooperative agreements were combined to create a seismic facility and a US-Array organized as SAGE operated by a single cooperative agreement with IRIS. The geodetic facility and the Plate Boundary Observatory (PBO) are operated by a cooperative agreement with UNAVCO.

A re-competition will be held for FY 2019. Currently, community input is being sought. There will be a workshop in May and a report at the end of the summer. Then the solicitation will be developed and cleared and it will be released around February. Proposals will be due early FY 2017. The National Science Board will review and new awards negotiated for the FY 2019 deadline.

She also discussed the Surface Earth Processes (SEP) group’s decision to pilot the “no deadlines” idea to give investigators more time to prepare fewer but better proposals.

Moving to trends in EAR core research, Dr. Frost discussed GEO’s Dynamic Earth document, which promotes the importance of maintaining vibrant core research that is community driven and is able to fund disciplinary, interdisciplinary and system-level science. The subcommittee members tasked the programs with asking how the focus of proposals changed over the past decade and providing an example of such a change.

The Sedimentary Geology and Paleobiology Program reported a change in focus from narrow, subdiscipline-based proposals to integrated, team-based projects. It cited proposals that study the interactions between and the coupled transitions of Earth and life through geologic time, emphasizing modeling and environmental change with a global/international perspective.

The Tectonics Program saw a change in focus with an increasing number of proposals that address problems that cross traditional program boundaries, especially with geophysics and geomorphology. Examples include coupling of uplift/exhumation processes with surface processes and climate; and integrated geological and geophysical investigations of fault zone behavior.

The Petrology and Geochemistry Program saw proposals enabled by new instrumentation and technique development that have enabled studies at smaller resolution and/or greater precision and the integration of experiments and modeling. Examples include multiphase flow dynamics in eruptive processes; early Earth processes captured in short-lived nuclides; and melt properties at lower mantle and core pressures and temperatures.

The Hydrologic Sciences Program has seen the boundaries of the discipline expanding with more focus on coupling between hydrologic processes and geochemical, ecological, and climatic phenomena. Examples include proposals using reactive tracers to quantify coupled water-nutrient fluxes in the hydrologic cycle and the integration of regional climate history into models for snowmelt contribution to groundwater recharge.

The Geophysics Program has seen a transition from data collection to synthesis and integration, novel tools and understanding induced seismicity. Examples include the deep Earth water cycle, exploration of discoveries of deep Earth structure, dynamics and evolution from planetary formation to present; and unraveling the role of slow slip in the seismic cycle.

The Geobiology and Low-Temperature Geochemistry Program is seeing more proposals in biogeochemistry and geomicrobiology; more proposals that combine field, experimental, and modeling studies and; less organic geochemistry and nanosciences. Some of the proposals funded that would have been seen earlier include geo-medicine to learn from geochemistry to benefit human health; and advances in “-omics” in understanding the function of microorganisms.

The Geomorphology and Land-use Dynamics Program has seen fewer proposals with a regional focus and fewer on continental glaciation; proposals that are more quantitative and involve numerical modeling; and topics that include fluvial processes, landscape evolution and the role of life. One of the transformative things they’ve seen is the application of LiDAR in understanding the Earth’s surface.

These examples show three trends: more proposals that cross traditional program, division and directorate boundaries; more emphasis on modeling, data synthesis and integration; and the emergence of research areas enabled by new tools, instrumentation and techniques. For the core programs, program officers say they have not had trouble accommodating these changes and work closely with PIs and POs in other programs, divisions and directorates to accommodate evolving research directions.

Discussion. Dr. Constable asked about the major research facilities and the re-competition and whether that is on a fixed time cycle and whether it is an efficient process that leads to reinvention or maintaining the status quo. Dr. Frost said the recompetition is mandated by the NSB, adding that it was EAR’s job to assure it is not an empty exercise and instead make it an opportunity to examine the science that has been done, needs to be done and what the community wants the facilities to be able to do.

Dr. Wakimoto followed up by endorsing what Dr. Frost had said, adding that he was watching the recompetition as well and said it did not have to be business as usual.

Dr. Fine asked if Dr. Frost was concerned about the increased emphasis on modeling. She said many modelers are being educated who “don’t even seem to know what data are” and think their modes are data. She asked if the shift was cost driven.

Dr. Doney responded that oceanography is moving toward more routine data collection, where many people will be working with data they did not collect and he emphasized the importance of proper education to emphasize the importance of underlying observation.

Dr. Hodges said in areas of the world that are difficult to access, modeling outstrips the data, resulting in models that have little to do with the observations.

Dr. Frost answered these points by pointing to EAR’s education and Human Resources program, which sees some of its programs becoming more interdisciplinary. But increasingly students are being reached in the first and second year and in community colleges and these programs are observation-driven. She added that a research program is only as good as the data it is founded on. Part of EAR’s mission is to safeguard the health of geoscience departments, which means being attentive to all parts, adding that she hoped proposals would not reach the funding level if not based on good observations and data as well as good modeling.

Dr. Hornberger concluded the discussion by saying that unlike oceanography, undergraduate degrees in geology and Earth Science tend to have a strong field observation component.

Dr. Hornberger continued by introducing EAR success stories as part of a conversation about conveying the value that EAR-funded science contributes. He said anecdotes about individual accomplishments tend to stay in people’s minds and this resulted in a pilot to assemble these stories. Dr. Hornberger offered the first short bio of a young student at Vanderbilt University. Other committee members followed with six brief presentations that detailed the accomplishments of students with particularly telling biographies in science.

Discussion opened with the suggestion that these types of stories should be disseminated on the Web and elsewhere because they grab attention.

Dr. Murray added that these types of stores help make the case for a return on investment and the contribution to the national security.

Dr. Sullivan added that it was also important to make clear to policy makers the value of the science and how that affects society.

Dr. Dixon suggested that adding biographies of historical figures would help captivate attention.

Dr. Hornberger said in response to a question that consideration had not yet been given for what to do with the stories that have been assembled. So far it has only been a test, but he said it was not just for EAR.

Dr. Bierman suggested that these kinds of stories could help with recruiting the next generation of students and keeping the field vital.

Dr. Constable said that Scripps Oceanography has considered using these kinds of stories as a recruitment tool by answering the question of what students go on to do after graduation and that students have other options than academia.

Dr. Sullivan said it was important to also emphasize science is not just a training ground for companies but has an impact on society and that breakthroughs in science can have an unparalleled impact on society.

Dr. Bierman said that evidence about the importance of science by itself doesn’t seem to be sufficient in many cases to convey its importance and that anecdotes can be an important addition to help persuade.

Dr. Hodges concluded by advocating for a website that combines both individual stories and the societal impact of the science.

**Advisory Committee Discussion on Returns on Investments in Geosciences Research.**

Dr. Davies said she was looking to the committee for ROI stories or suggestions for where to go from here.

Discussion. In response to a question, Dr. Davies said ROI materials would be made available on the Web.

Dr. Voorhees suggested looking to the Integrate Project, co-funded by EHR and GEO, which is developing a resource for community developed programs and lesson plans and other resources to use in the classroom.

Dr. Davies said her group’s goal was to convey the importance of geosciences with the general public. They can be use to highlight a story on the Hill or provide research to highlight in talks at a university or elsewhere. She would like to develop additional communication materials that will help spread the word that geosciences provides good jobs to do a better at communicating the relevance of geosciences.

Dr. Kempton suggested that the messages are going to be different for different audiences.

Dr. Davies described three audiences: opinion leaders, the general public and the NSF community.

Dr. Constable referred to a recent study that projected a shortfall in the number of trained geo scientists and asked how this is compatible with geosciences being considered not a science. Teaching of geoscience has not communicated the idea that geosciences rests on physics, chemistry, biology and mathematics.

Dr. Arroyo said the role of the messenger, in the addition to the message, was important and suggested using members of the military who can speak to the impact of climate change on national security.

Dr. Davies agreed but added a caution because NSF can’t legally ask third parties to speak in favor of geosciences.

Dr. Arroyo responded that there was a way to capture their factual stories about their use of ships, etc.

Dr. Davies asked for references to PIs who can be featured who would speak to youth and diversity.

Dr. Dixon said it was important to define a number of target audiences and go to those who are receptive, including educators and others who can convey the message.

Dr. Taylor said that GEO-generated intellectual property (IP) may not be proportional to NSF funding. He added that the ITIF report was not the basis of politicians’ concern, though they appeal to it to support their arguments. And the arguments that GEO makes will not change their views. He suggested that the best example to use is fracking, which has had a large impact on the economy, adding that NSF provided some of the early funding for work that lead to fracking.

Dr. Cavanaugh asked if the history of fracking had been written. A committee member answered that a book has been written on fracking but does not make the connection to academia.

Dr. Arroyo suggested that the nexus with GEO was the effort by states to regulate fracking, which requires science input to determine how it can be done safely.

Dr. Kempton said industry is not interested in promoting science in order to limit fracking, making it difficult to make the economic case for Earth science.

Dr. Davies cited a letter a congressman wrote saying the geosciences could be done by other agencies than NSF, even though, she noted, NSF is not a regulatory agency. Picking up on the idea of misinformation Dr. Hornberger cited a statement made on the on House floor that NOAA could be disbanded and rely instead on the Weather Channel.

Dr. Taylor said the military is far ahead of Congress in dealing with the realities of climate change, but this does not mean that Congress members will change their views.

Dr. Hodges said there was a value in getting these messages out in stealth ways, by framing the issue in practical and neutral terms. Messages, he added, should be targeted to state governments because they do not have as much access to information as those at the federal level. He endorsed the idea that every scientist should adopt at least one person in a state legislature to be the go-to person for answering science-related questions.

Dr. Hornberger said he was working with the American Geosciences Institute, which has a critical needs document, to divide critical needs into separate messages for energy and climate. So while NSF puts together water sustainability and climate, the message could instead focus on water resources management or earthquake preparation.

Dr. Davies said fact sheets (Research in Your District) had been prepared that are specific to specific areas of the country to use for a briefing for the members of Congress from a single region.

Dr. Taylor added annual climate prediction in the area of water resources is central to the food-water-energy nexus and is a highly political, socially relevant, topical issue that the nation would love to solve soon.

Dr. Constable said large energy companies do similar long-range planning to that of the military and there is room for dialog with that group.

Dr. Semeter suggested that GEO has a story to contribute to the emerging discipline of big history, though geoscience is usually not included in popular media on the topic. If it were it could be used for broad outreach and to excite the public imagination.

Dr. Fine said it might be useful to frame issues in terms of public health.

Dr. Hornberger referred to the book, *The Collapse of Western Civilization: A View From the Future*, which implicitly criticizes geosciences for not sufficiently expressing concerns about climate change, and said social psychologists say a message has to be explicit, rather than general, to be effective. But he said geoscience cannot be explicit and be confident. To be relevant the message has to be specific and passionate, but scientists must be cold, aloof and talk in generalities.

Dr. Stroeve added that cautiousness is built into predictions to avoid being wrong down the road.

Dr. Hornberger said climate scientists have been taken to task for the mismatch between the content of a dire message and the calm, steady voice in which the message is delivered. Attention could be grabbed by being sensational, yet there is concern about being sensational, he said.

Dr. Kempton followed up by asking if there is an opportunity with the investment in PREEVENTS to have a component about the education of the public on uncertainty.

Dr. Arroyo said the flip side of that point is teaching the science community how the words “uncertainty” and “theory” are used in Washington. She said her center is developing fact sheets that are relevant to government officials at the state and local level. This is combined with media training to learn to be careful about the language used.

Dr. Whittaker said the relevance to public health has been overlooked in messages conveyed to the public. Also, the most vulnerable part of the population is the least informed.

Dr. Dixon said it was important to determine the audience for the message and suggested working with geoscientists in Texas, an area rich with both anti-science and geoscience, and state legislators and public sectors receptive to the merits and mission of science. The discussion, he said, has to be carefully formulated.

 Dr. Hodges said the past is increasingly the key to understanding the present and the future. Though there are constraints in making predictions, the point should be made that there is a very long record of information for data on climate change.

Dr. Doney said the Woods Hole Oceanographic Institution is in collaboration with other organizations to test and develop messaging for docents at aquariums and museums.

**Preparation for Meeting with the NSF Director.**

Dr. Hornberger led the committee in a discussion of possible questions to ask Dr. France Córdova during their upcoming meeting.

**Meeting with the NSF Director, France Córdova**

After an introduction by Dr. Hornberger, Dr. Córdova said she would like to make her meeting with the committee more of a conversation and invited each member to make a brief introduction and then asked for questions.

Discussion. Dr. Bierman began by asking how her vision for the Foundation had changed over the last year and where the Foundation is heading in the next couple years.

Dr. Córdova said the Foundation has a unique role investing in fundamental research. NSF funds more researchers at the beginning of their research than most agencies. But as part of the federal government, NSF must be adaptive and responsive to changes and pressures, which are often cyclic and political and can be based on beliefs more than the scientific method. There is a constant interplay between being true to the Foundation’s mission and having the wherewithal to fund the best fundamental research and researchers by being responsive to and navigating external pressures. She said her role is largely with the stakeholders who put pressure on the Foundation. The FY 2017 budget process is beginning and she is working closely with the ADs on that gathering community input. She said her role is more to facilitate their work with the scientific communities and to be engaged with Congress, the White House, the academies and the scientific societies to ensure they are working with the Foundation to preserve NSF’s investment in science.

Responding to a follow-up question about her priorities for the future, she said one priority is making sure NSF’s budget is sustained and hopefully increased. Another priority is to assure the Foundation’s messages gets out in ever better and more profound ways. She said the agency is constantly working on its narrative and how to talk to different stakeholders about why this investment is so important, the advances that have been made, the new scientific questions that are being asked, and why those matter to its constituents. She also said she cares very much about the Foundation’s initiatives, mentioning food-energy-water systems, understanding the brain, risk and resilience and the INCLUDES imitative.

Dr. Fine asked how choices are made in balancing basic research, education facilities and other areas.

Dr. Córdova said all decisions were made within the context of how much is available to invest. She referred to three budget scenario vectors, down, up and flatish. With the input of the advisory committee reports, the core research is excellent and there is no evidence for taking it down in any area. The importance of the research of each directorate has been reaffirmed with demonstrable evidence of its impact. There is not a case therefore for changing priorities. But the Foundation has to be open to new ideas, new scientific questions, a new discovery that can be a new tool, or the discovery of a new natural phenomenon. So NSF has been asking the directorates to look at a couple percent budget decrease and ask for ideas that are important across scientific and engineering disciplines that all the units agree it is worth a modest reduction to put that into a common fund. The FY 2016 budget has an increase of 5 percent, which will provide additional funding for those cross-directorates, if that funding level is approved.

Dr. Hornberger asked if Dr. Córdova had any ideas about what can be done to publicize the value of the geosciences.

Dr. Córdova answered that better communication is always an answer to every problem. The Foundation needs to keep making the case why its investment is important. She said allies in the business community, scientific community and in Congress are very important. There is much more respect in Congress, she said, for the decadal surveys and she is often asked if the Foundation is being responsive to these reports. If we don’t follow the advice of a decadal survey there must be an extenuating circumstance that can be defended, she said.

Dr. Barth asked to hear more about INCLUDES and the role of geosciences in that initiative.

Dr. Córdova answered that every directorate fits with INCLUDES. It is important that people from all sectors are being attracted into the discipline and there is a concern about access and opportunity and that there are biases that set obstacles to extending that welcome to women and minorities. More recently there has been attention to socioeconomic inequities. The initiatives NSF funds that can be broadly constituted as broadening participation constitute a big list and a large amount of money, which the Congressional Research Service estimated at $755 million. She is looking at impact, how NSF programs leverage other programs, and how the programs can be made more known and available. She said the agency does not have a good handle on how to take something that works locally and provide it to others to use as a model. There will be a small workshop on June 3 to discuss this issue, which she said was a networking problem. Something has to be done differently, she said. The centers NSF funds should be able to provide thoughts about scaling and making a bigger, faster difference.

Dr. Arroyo followed up with a question about how the impact of individuals, which can produce profound changes in people’s lives on the micro level, is being measured and tracked.

Dr. Córdova said she didn’t know how to assess that impact and said some original thinking is needed.

Dr. Doney asked about the formal evaluation of the integration of Polar into GEO, how that will move forward, the timeframe and getting community engagement and feedback.

Dr. Córdova said her predecessor had made informal remarks about a nominal three-year review period. She estimated it would start in January with the report finalized by the end of 2016.

Dr. Kempton asked for the director’s vision for international collaboration.

Dr. Córdova said there was a reorganization this week with International as its own entity. The division has programs such as Partnerships International Research and Education and the Graduate Student Opportunities Worldwide and conversations with the State Department have been started to identify other science-diplomacy efforts NSF can participate in. NSF, she said, should have more of a seat at the table at international meetings. In that vein, she also mentioned her involvement with the State Department’s effort to set up collaboration between universities in Mexico and the Mexican equivalents of NSF. She also mentioned the involvement of the Secretary of Energy’s involvement in nuclear negotiations with Iran. Science and engineering can help inform policy worldwide and there is a need to move in that direction, which goes to the origins of NSF. She also referenced her upcoming attendance at the Global Research Council meting in Tokyo to focus on open access, merit review, and graduate student programs.

Dr. Taylor noted that the U.S. will take over chairmanship of the Artic Council and asked if the reorganization was coordinated with that.

Dr. Córdova said that she is the chair of the International Artic Research Council (IARC) and so will head up the international group that looks at research policy and make that more coherent.

In response to a question from Dr. Doney about U.S. participation and engagement of NSF-funded researchers in the upcoming Our Ocean Conference in Chile, Dr. Córdova said it was not on her radar but would follow up during her upcoming trip to that country.

Dr. Córdova also discussed her recent visits to GEO facilities.

She closed by discussing the *Sea Change* report, which she called terrific in terms of both the content and its construction and said she used it as a model for her ADs on starting out the dialog on advances in new directions for the FY 2017 budget. She singled out the report’s language on involving the scientific community in setting goals and emphasized the importance of taking that input very seriously in setting directions.

Dr. Hornberger thanked Dr. Córdova for meeting with the committee.

**Thursday, April 9, 2015**

**OCE Subcommittee Meeting (Committee of the Whole)**

Dr. Richard Murray, Ocean Sciences Division Director, who started in January, reviewed changes in division personnel and presented the OCE FY 2015 funding.

He then turned to the focus of his presentation, the Decadal Survey of Ocean Sciences, 2015-2025. The report, he said, is a wake-up call but not a surprise. The report is having an impact on NOAA and ONR and many other organizations are paying attention to the report and the major generational change in ocean sciences. Institutions and funding agencies, he said, need to reflect this and respond.

Comparing budget trends from 2014 to 2015, he said the science and infrastructure budgets are getting closer together but there is still a ways to go.

Dr. Doney noted that the two do necessarily have to be the same. The issue is the right infrastructure to do the desired science.

Dr. Murray agreed and went on to say the report is well crafted and hits the big picture accurately in that infrastructure is taking an increasing portion of the budget. The report recommends that it is getting too large, but that depends on the agency, he said. The question, he said, is determining the correct mix. Because of the declining success rate on proposals in the last couple years, though, a reorientation is needed. The report outlines options without severely limiting discretion. He predicted this report would have a very long shelf life.

Dr. Wakimoto said when he asked the co-chairs of the report how they generated the range of numbers he was told it was a qualitative measure.

Dr. Murray said his discussions with people in the community back that idea of a qualitative assessment driven by declining success rates. Their sense is that submitting a proposal is too much of a crapshoot, where high scores don’t result in funding.

He listed the science priorities (not ordered) from the report as:

* Rates, mechanisms, impacts, etc….sea level rise?
* Coastal, estuarine ecosystems and linkages.
* Ocean biogeochemistry & physics…and climate.
* Biodiversity & resilience of ecosystems, & changes.
* Marine food webs in the coming century.
* Formation and evolution of ocean basins.
* Geohazards (‘quakes, tsunamis, landslides, volc.).
* Subseafloor biosphere; biogeochem cycles & life.

Excellent ocean science will continue to be funded, regardless of the topics and maintaining the highest standards of external and internal review, he said, noting that the priorities do not cover everything in ocean sciences. On the other hand, if a proposal hits all eight of the priorities but is poorly written, it will not be funded.

Dr. Murray also discussed the alignment of current NSF-funded ocean research infrastructure to the eight decadal science priorities. He also showed a diagram that mapped science and infrastructure with cost on one axis and relevance on the other. The message, he said is to not over-interpret the smaller details and that large-scale assessment is most important.

Turning to Chapter 4, “The Path Forward: Maintaining Ocean Science in a Constrained Budget Environment,” he reviewed the recommendations:

* Maintain balance b/w infrastructure & core research.
* Reduce O & M, increase core; Infrastructure ≤ 40-50%.
* Immediate 10% reduction in infrastructure, plus further 10-20% over next 5 years.
* Weighted Cuts. OOI ~20%, IODP ~10%, Fleet ~5%.
* Regional Class Research Vessels (RCRV). Two, not 3.
* Infrastructure reviews every 3-5 years with a 10-yr outlook. Exit strategies, etc.
* Initiate high-level standing infrastructure oversight committee.
* Expand partnerships: Other agencies, international, other sectors.

He said the most significant points were the infrastructure reduction, the weighted cuts and the RCRV recommendation.

Moving to OCE’s fifth comment on the report, he listed the following points:

* Staying focused on science.
* Will strive to maintain, or ideally enhance, science goals via the “return of funds to core.”
* How can we, as a community, do things differently now than we could in the past?

He added that often the same individuals who are affected by the decrease in infrastructure are being positively affected by the increase in core funding, reducing negative reactions to the report.

Wrapping up his presentation, Dr. Murray discussed the question, Where do we stand as of now? He answered this by noting that:

* No decisions finalized.
* Goal: “Reply” in late spring.
* Other aspects…
	+ Cyberinfrastructure throughout OCE.
	+ Governance & community engagement of OOI.
	+ Technology and development.
	+ Partnerships (interagency, private, etc.)

Dr. Taylor added that the study was being conducted while budget figures were still changing, with hard numbers only for FY 2013. The move of $25 million from Seas to core across the directorate was already in play though and there was also a large change in the cost of fuel, which provides some headroom that was not in the planning.

Discussion. Dr. Fine voiced her strong support of the report. The community is so positive because diversity is good for the health of the community. The idea that one leg of the budget had kept growing was unhealthy for the community. For an NRC report to make sensible, substantive recommendations is remarkable.

In response to a question about how one makes cuts in programs that are underway, Dr. Murray said the first thing was to establish a baseline. They then did rough calculations on how replacing the loss of infrastructure, whether it can be done less expensively and, if so, by how much. This was done with an awareness that all activities are linked. Some changes are being made immediately, but others are more implementable in FY 2017 and 2018.

Dr. Taylor noted that as the report was being prepared, IODP had been recompeted, requiring a contract change.

Dr. Doney asked what role the Ocean Subcommittee and AC/GEO can play.

Dr. Murray said any feedback now or in the coming weeks is welcome. Over the longer term, OCE will be coming back for ideas about infrastructure reviews, the standing infrastructure oversight committee and expanded partnerships. There has not been enough from the geoscience and OCE community, he said.

In response to a comment from Dr. Kempton that there was tremendous potential for savings from international partnerships, Dr. Murray said OCE already did ship bartering, though there is more financial leverage the U.S. may be able to take advantage of. He said the world is getting flatter and more linked and OCE hoped to take advantage of that.

Dr. Hornberger said MREFCs often cause angst and asked Dr. Murray if he sensed a lack of enthusiasm in the community. Dr. Murray responded that a certain amount of resistance was human nature, but most understand things have to change.

Dr. Wakimoto said that the math and physical sciences also have huge facilities, as do the centers and the default response is to protect the facilities. He asked the advisory committee to step back and look at the entire portfolio, to include the earth sciences, NCAR, and atmospheric and geospace.

In response to a question about how the infrastructure oversight committee will be structured, Dr. Murray said OCE has not yet had time to explore that, but he added that non-OCE people should be involved.

Dr. Taylor said the Advisory Committee has to look at the balance of the disciplines within the geosciences and the geosciences within NSF and has an important role to play in the oversight of the whole. The issue of how well the infrastructure is enabling critical frontier science is also a question for this committee. He also raised the issue of what NSF will do internally to consider how they conduct business—Is the structure within OCE going to stay the same, for example? The Advisory Committee will have the opportunity to comment on that at the next meeting.

Dr. Taylor also read a comment received electronically from Dr. Carr: Good science happens using major infrastructure but GEO needs to consider whether to be like NASA, with major investments into enabling platforms. The report enables moving in good directions to reassess.

Dr. Wakimoto said the NSF response will likely occur before the next meeting, but there will be an opportunity for an interim response from the committee. Also, he suggested appointing a liaison to the high level standing infrastructure oversight committee.

Regarding a suggestion from Dr. Hodges about an interagency task force to look at partnerships, Dr. Murray said there are already discussions between the agencies. There are also conversations about integrating better with NOAA.

**AGS Subcommittee (Committee of the Whole)**

Dr. Shepson said he became division director in September and was delighted by the help of the staff and was pleasantly surprised by the range of diversity in AGS, scientific and otherwise.

He briefly reviewed the changes in AGS in the past year and said one of his main objectives is to assure the highest quality and happy staff. He reviewed the other staffing changes, including all new section heads. Half of the staff in geospace sciences have retired in the past year, he said.

Dr. Arroyo reviewed the April 1 AGS virtual committee meeting. She discussed an update on the geospace sciences section, including a portfolio review committee that will be reviewing what geospace is doing in terms of funding in science and how the facilities fund the science projects and following the recommendations of the decadal surveys with the question of what the facilities are capable of supporting in terms of the community recommendations, given the flat budget environment. The committee members have a broad spectrum of knowledge. The goal is to have a draft report by the end of September.

On atmospheric chemistry there is a national academy review through an ad hoc committee to establish scientific priorities within the atmospheric chemistry discipline for the next decade to find resource needs and pursue research infrastructure. There have been recent town hall meetings and there is work ongoing at NCAR through the new laboratory. The meetings generated ideas for what should be addressed in the report, which has a one-year timeline.

Dr. Shepson said he was delighted at the turnout and the intensity of the commitment. It has been a long time since the atmospheric chemistry community has contemplated its intellectual naval in this way it is great, he said, that the NRC process is going on.

Dr. Arroyo said the virtual meeting also discussed the strategic plan. A draft document is to be completed sometime soon. It will try to engage the AGS community and will account for feedback from previous NRC review processes. The plan is being designed to be useful to the AGS community at large and fit into the broader discussion about funding and priorities. Completion is scheduled for 2016.

There was also discussion how to integrate that planning into agency-wide initiatives. There is clearly a strong role for this directorate in cross-agency initiatives and multi-agency partnership opportunities. The document is being designed to be useful for early career investigators. There was a discussion of the emphasis on broader participation. This will be an important part of the strategic planning process.

Dr. Shepson added that the division produced a document last year that received NRC review. AGS is rewriting the plan taking into account this input to make the document more strategic and forward looking, including balancing infrastructure with the idea of supporting core science and enabling transformative science. When there is a draft that has received full community input, the NRC review will be done again. He added that there is a year-long diversity education and outreach strategic plan at NCAR. He predicted the plan would do a good job of discussing metrics about broadening participation objectives.

Dr. Arroyo said the virtual meeting also discussed facilities, including A1 storm penetrating aircraft, that has been transferred from the Air Force to NSF and will be ready to be used in the spring of 2016. Also re NCAR, there will be a committee of visitors this summer. The cooperative agreement is up for renewal in September 2018.

There was also discussion at the meeting of workload and morale issues. There was an emphasis on the call to make the right staffing decisions and getting the right people in place as soon as possible. There are also NSF efforts to minimize some of the organizational overhead burden experienced by program officers.

She concluded by saying she hoped others will commit, as she has, to having conversations to articulate the importance of the geosciences and support for this kind of work to society and to the economy.

Dr. Shepson followed up on the issue of workload and morale, saying there is steadily increasing proposal pressure. With a happy professional division with everyone acting as a team and a director who has people’s backs, the workflow feels less heavy.

Dr. Shepson said that AGS infrastructure includes airplanes, geospace infrastructure, and other science support infrastructure. He said AGS will continue to engaging the community and NRC in the process of self-reflection of how AGS is structured and supporting the best science.

The program officer for Antarctic Astrophysics and Geospace Sciences continued the presentation, beginning with an overview of geospace showing that Polar Programs has Antarctic Geospace and that NCAR has the High Altitude Observatory. Programs include Aeronomy, Geospace Facilities, Magnetospheric Physics, Solar-terrestrial Research and Space Weather Research. The AGS budget is approximately $250 million and the Geospace Section (GS) is about $43 million in FY 2014.

He also reviewed the staff changes, including Acting Section Head Vladimir Papitashvili.

A budget breakdown was provided for GS research programs ($43 million), including Aeronomy ($9.2 million), Magnetospheric Physics ($6.8 million), Solar Physics ($7.3 million), Space Weather Research ($5.7 million) and Geospace Facilities ($14 million). He also broke out the budgets for GS facilities ($14 million).

Showing the geospace budget from 1999-2015, he noted an increase of 60 percent, about 40 percent of that is inflation.

A portfolio review was initiated about a year ago. It was motivated in part by priorities highlighted for the Geospace scientific community in the National Research Council's *Decadal Survey: Solar and Space Physics – A Science for a Technological Society (2013)* and by the current challenging outlook for the U.S. Federal budget.

It examined the balance across the entire portfolio of activities supported by NSF’s Geospace Section within the Division of Atmospheric and Geospace Sciences.

It also ensured that GS investments are guided by and aligned with the above-cited Survey recommendations. These recommendations should encompass not only observational capabilities, but also theoretical, computational, and laboratory capabilities, as well as capabilities in research support, workforce, and education.

The portfolio review will consider not only what new activities need to be introduced or accomplished, but also what activities and capabilities will be potentially lost in enabling these new activities and discontinuing current activities.

The review committee is headed by William Lotko of Dartmouth College.

The timeline for the review includes these milestones, some of which have already been reached:

* PR Committee membership (13 members; January 2015)
* Criteria and strategy (January-February 2015)
* PR Committee Charge and Formation (February 2015)
* PR Teleconferences (March 4, 16, and 31, 2015): collecting and assessing GS data
* First PR Committee in-person meeting at NSF (April 6-7, 2015)
* Community input: via geoagsgsportfolio@nsf.gov and workshops (Apr–Jun 2015)
* PR Committee drafts their report (June – July 2015)
* Second PR Committee in-person meeting at NSF (July - August 2015)
* GS Portfolio Review Report to GEO/Advisory Committee (September 2015)
* Pursuing option to have this draft reviewed by the NRC/CSSP Committee
* GEO/Advisory Committee reviews the GS/PR Report (October 2015)
* GS programs response to the PR Committee Report (November 2015)
* Final (revised if necessary) GS/PR Report released (December 2015)

He also presented a draft of the table of contents for the recommended program for science and capabilities, 2016-2025. He mentioned that the committee is looking at how existing facilities are mapping into science section support.

He mentioned the 2013 Decadal Strategy for Solar and Space Physics, which includes the DRIVE initiative to provide high leverage to current and future space science research investments. There are five DRIVE components:

* Diversify observing platforms with microsatellites and midscale ground-based assets.
* Realize scientific potential by sufficiently funding operations and data analysis.
* Integrate observing platforms and strengthen ties between agency disciplines.
* Venture forward with science centers and instrument and technology development.
* Educate, empower, and inspire the next generation of space researchers.

Next he discussed diversifying observing platforms with microsatellites and midscale ground-based assets:

* CubeSat Program
	+ Two new Cubesat projects are at work: QBUS and ELFIN (NASA with NSF’s participation)
	+ NSF’s Cubesats: ExoCube and Firebird-II were launched January 31, 2015; CADRE is scheduled for launch in 2015

Realizing scientific potential by sufficiently funding operations and data analysis:

* Six incoherent scatter radar sites, Lidar Consortium
* New Ionospheric Heater at Arecibo Observatory

Integrating observing platforms and strengthen ties between agency disciplines:

* SuperDARN is a worldwide collaboration of 34 radars funded by 11 different countries
* SuperMAG – global geomagnetic database & service

Venturing forward with science centers and instrument and technology development:

* AMPERE- II at Iridium NEXT
* Global Space Weather Research Facility

AGS efforts to educate, empower and inspire the next generation of space researchers includes:

* Faculty Development in Space Sciences: New Biennial Solicitation
* Two awards in 2015 (Univ. of Minnesota and Univ. of Illinois at Urbana Champaign
* Continue efforts to train the next generation of space scientists through proactive efforts within the GEM, CEDAR, and SHINE Programs
* Continue to support Research Experiences for Undergraduates programs and sites through both the formal and informal programs at the universities, laboratories, centers, and facilities
* Support early career scientists through the NSF CAREER Awards program
* Sponsor Geospace workshops and conference, such as CEDAR, GEM, SHINE, Space Weather Week, Space Weather Enterprise Forum, TESS-2015, MSSP-2015, etc.

The key science goals of the decadal survey include:

* Determine the origins of the Sun’s activity and predict the variations in the space environment. *NSF/Geospace Section: ~$7.5M annually (STR)*
* Determine the dynamics and coupling of Earth’s magnetosphere, ionosphere, and atmosphere and their response to solar and terrestrial inputs. *NSF/Geospace Section: ~$25M (all programs)*
* Determine the interaction of the Sun with the solar system and the interstellar medium. *NSF/Geospace Section: ~$0.5M (STR & Antarctic Geospace*)
* Discover and characterize fundamental processes that occur both within the heliosphere and throughout the Universe*. NSF/Geospace Section: ~$10M*
* NCAR/High Altitude Observatory:
* ~$5.5M in Geospace Research & Facilities
* Mauna Loa Solar Observatory
* Community Spectropolarimetric Analysis Center
* Thermosphere Ionosphere Global Circulation Models
* NSF/Antarctic Geospace Sciences Program
* ~$2.5M for Geospace Research & Instrumentation

Discussion. Dr. Wakimoto provided a global perspective for GEO and how the geospace portfolio fits. He mentioned the decadal survey as one extreme of going to the academy. At the other end of the spectrum, the astronomy field also had an NRC report that went through priorities and a portfolio review by a subcommittee of the NPS Math and Physical Sciences Committee Advisory Committee. They came back with a prioritization of what facilities were the most important that matched to the NRC report. As geospace was articulating its plan, he said he was nervous that whatever came out of the portfolio review might not withstand possible community push back, so he suggested injecting the academy and taking the portfolio review from the committee as a reality check. It would appoint a separate panel with a broad membership and report back whether they fully endorsed the portfolio review committee, or made other recommendations. He described this as a hybrid approach.

Dr. Vladimir Papitashvili added that there was also activity at the Office of Science and Technology. It is a multi-agency cold space weather operation research and mitigation task force, including NSF. In addition to a strategy document there are action plans. There is an opportunity for public comment on the strategy document at the end of April. The action plans are viewed by agency heads. That will be out by the October meeting.

Dr. Arroyo referred to a disruptive power outage in Washington recently and said solar storms produce much more disruption. This could be an opportune time, therefore, to draw attention to the vulnerabilities to the grid and try and get support.

Dr. Taylor said one of the study boards of the academies is about to embark on another decadal-like survey and he asked if the other things discussed are being coordinated with where this survey is heading. An area where there will be a game changing effect will occur in five to 10 years is satellites.

Dr. Semeter responded that the geospace section is interested in the diversity of facilities and discussed the effort to define what a facility is. *Sea Change* uses facility and infrastructure together. He discussed comparing the relative merits of a large monolithic observatory and a fleet of CubeSats doing distributed sensing in space. The geospace community has some missions coming up that will need a place like Arecibo to validate NASA data.

Dr. Shepson said he attended most of the portfolio review meeting. The meeting was vital, thoughtful and candid, he said, and he realized the review will be a difficult report with tough cost benefit calculations.

Dr. Cavanaugh said she was struggling with the word “balance” in the context of infrastructure and science. It drives one to thinking in terms of a 50-50 split and she suggested possibly changing usage from “balance” to “optimization.” How do you optimize expenditures so you have the infrastructure you think is important?

A member of the audience said the Space Studies Board is the lead on the decadal survey. They had a meeting last week to continue the scoping process. The board does not want to retread the recommendations already identified though the Climate Change Science Program, but should be thinking of where there are overlaps. Now is a good time for the community to identify any need there might be for attention to that overlap, she said.

Dr. Hornberger said he was glad to hear there had been a discussion of diversity issues during the teleconference.

**Action Item**: For the fall meeting it will be important to get an update on INCLUDES, Dr. Hornberger suggested.

Dr. Wakimoto agreed with adding INCLUDES to the fall agenda. The task is to build on the initiative as a base and devising a network to scale up.

Dr. Fine mentioned an initiative across the geosciences called GeoLead, for Geosciences Learning, Engagement, and Development.

In response to a question about progress on broadening participation, Dr. Wakimoto said progress was OK, but not good. He said GEO is not at the bottom but not in a place he likes.

In closing, Dr. Shepson followed up by mentioning the AGS was making progress in some areas in encouraging and enabling women in science but not doing well with African American participation. He stressed the need to focus on pipeline issues, encouraging undergraduates. CubeSat, he suggested, could be used for recruiting into geospace.

**NRC Decadal Survey of Ocean Sciences**

Dr. Yoder said NRC believes there is a bright future of ocean science and the report will help ensure that. He discussed the OCE budget by program, showing each declining. Infrastructure projects were started during a period when a rapid growth in the budget was anticipated, though the projected budget increases did not materialize.

The committee’s charge was to:

* Review the last decade’s accomplishments,
* Provide a concise set of compelling, high-level scientific questions for the next decade
* Assess current NSF ocean infrastructure portfolio
* Analyze alignment between current portfolio of NSF ocean science investments and science priorities assuming no budget growth
* Identify opportunities for NSF to complement other federal agencies to avoid duplication, encourage collaboration and shared asset use, and maximize the value of NSF ocean science investments.

Dr. Yoder also reviewed the committee roster, which included five National Academy members.

Discussing the ratio of science to infrastructure, he displayed a graphic showing that most funding (62 percent) went to science in 2001 and how this declined to 46 percent in 2014.

Dr. Yoder discussed the methods used for determining the decadal science priorities and listed them without prioritization:

* What are the rates, mechanisms, impacts, and geographic variability of sea level change?
* How are the coastal and estuarine ocean and their ecosystems influenced by the global hydrologic cycle, land use, and upwelling from the deep ocean?
* How have ocean biogeochemical and physical processes contributed to today’s climate and its variability, and how will this system change over the next century?
* What is the role of biodiversity in the resilience of marine ecosystems and how will it be affected by natural and anthropogenic changes?
* How different will marine food webs be at mid-century? In the next 100 years?
* What are the processes that control the formation and evolution of ocean basins?
* How can risk be better characterized and the ability to forecast geohazards like mega-earthquakes, tsunamis, undersea landslides, and volcanic eruptions be improved?
* What is the geophysical, chemical, and biological character of the subseafloor environment and how does it affect global elemental cycles and understanding of the origin and evolution of life?

He described major OCE infrastructure as:

* Annual budgets > $5M/yr
	+ Academic research fleet: $83M/year (2014)
	+ Scientific ocean drilling (IODP): $250M over next 5 yrs ($50M+/year)
	+ Ocean Observatories Initiative (OOI): $55-59M/year (2015-2019)
	+ National Deep Submergence Facility: $7.3M (2014)
* Comprise > 90% of annual infrastructure budget

The committee’s approach to aligning infrastructure to the science themes resulted in the following guidelines:

* Match each science priority with the existing infrastructure
	+ Also identified gaps not available through OCE/NSF
* Match each infrastructure component’s specs and goals to the science priorities
	+ Emphasized infrastructure that served many science priorities

Dr. Yoder presented a graphic summarizing infrastructure cost vs. relevance with ships, for example, having high cost and high relevance and OBS with low relevance and cost.

He listed the recommendations as:

1. Fiscal planning:
	1. In order to sustain a robust ocean science community:
		1. *need balance of investments between core research programs and infrastructure.*
		2. *infrastructure expenses should not be allowed to escalate at the expense of core research programs.*
2. Rebalancing the budget:
	1. OCE should strive to:
		1. *reduce the O&M costs of its major infrastructure*,
		2. *restore funding to core science and OTIC within the next five years* and
		3. if budgets remain flat or have only inflationary increases, *adjust its major infrastructure programs to comprise no more than 40-50% of the total budget.*
3. Immediate & sustained Cuts:
	1. With the ultimate 5-year goal of *rebalancing major infrastructure costs to core science:*
		1. *initiate an immediate 10% reduction in major infrastructure costs,*
		2. *then an additional 10-20% decrease by 2021,*
		3. *strengthen core science,*
		4. *invest in technology development, and*
		5. *develop funding partnerships* to address the decadal science priorities.
4. Distributing cuts:
	1. The *immediate initial 10% cost reduction* in major infrastructure should be distributed, with the *greatest reduction applied to OOI, a moderate reduction to IODP (2013-2018), and the smallest reduction to the academic research fleet.*
		1. Suggested weighting: *immediately reduce OOI by 20%, IODP by 10%, and the UNOLS fleet by 5%*.

Options for distributing cost reduction:

* + OOI:
		- Cut 2 global moorings
		- Reduce coastal array, cabled observatory, and admin by 10%
	+ IODP
		- Raise revenue from international partners
		- Increase external funding for operations
		- Reduce science services
		- Reduce the number of expeditions
	+ Fleet
		- Lay up Langseth seismic ship
		- Consolidate Atlantic Intermediate ships
		- Consolidate Pacific Intermediate ships
1. Regional Class Research Vessels (RCRVs):
	1. NSF should *reconsider whether the current RCRV design is aligned with scientific needs* and is cost-effective in terms of *long-term O&M*, and should plan to *build no more than two RCRVs*.
2. Broad program reviews:
	1. Program reviews for OOI, IODP, the academic research fleet, and NDSF should occur periodically (nominally every three to five years, with a 10-year outlook) and should be considered within the context of the broader OCE budget environment, rather than independently.
	2. OCE should *consider exit strategies for major acquisitions* if funding is insufficient, and *seek periodic community input to* help *ensure infrastructure is aligned with science priorities*.
3. Infrastructure oversight:
	1. OCE should initiate a high-level standing infrastructure oversight committee to evaluate the entire portfolio of OCE-supported infrastructure .
	2. The outlook should be for at least 10 years and should include discussion of the lifecycle costs.
	3. Committee membership should include professionals experienced in long-range budgeting and strategic planning.
4. Partnerships:
	1. The committee encourages OCE to expand its partnership capabilities with other federal agencies, international programs, and other sectors to help spread the costs of major ocean research infrastructure beyond OCE.

In closing, Dr. Yoder listed NRC’s final recommendations:

* Take immediate action to restore balance between infrastructure and science
* Set strategic boundaries
* Have a long-term plan to maintain balance
* Stay “within the channel.”

Discussion. Dr. Wakimoto said NRC’s task was incredibly difficult and he couldn’t be more pleased with the report. Also, he noted that the NSF Director holds this report up as a standard with other directorates.

Dr. Yoder responded to a question about the OOI costs saying they are not projected to go down over time. The installation costs are covered by the MRE account. He also said that the IODP long-term costs of archiving the cores are separate, as is the science.

Dr. Murray clarified that the percentages across the board (20, 10, 5) are only for O&M. There is no consideration to decreasing the fleet size.

In response to a question about involving the community in decisions about sunsetting programs, Dr. Yoder said the people most interested are those who want to keep the programs going. There are specific programs that sunset but IODP has a different status and attention was not given to considering sunsetting that.

Responding to an inquiry about feasibility given the peer review and ship planning timescales, Dr. Yoder said that was discussed and he acknowledged the difficulty. He added that it was difficult engaging international partners but suggested some possible opportunities.

Dr. Glickman acknowledged the help that was received from NSF program managers. In response to a question regarding the AHP methodology, she said it was done on an informal basis.

Dr. Yoder added that new technology to reduce costs and cyber infrastructure were not examined closely, due to insufficient time.

On a question about feedback from other agencies, Dr. Glickman said most of the response was from NOAA regarding OOI.

Dr. Yoder answered another question about considering human capital part of infrastructure by saying he brought it up at the first meeting but the committee decided against that path. There is, however, the possibility of a subsequent report looking at that, along with education and manpower issues. Dr. Murray added this was the next logical step of the entire conversation of the evolution of sciences. In response to a related question on funding young researchers, Dr. Murray acknowledged this as a major concern. He added those involved in medical training have developed model for better engaging the current young generation. Dr. Yoder added that discouragement among those in their mid-career and those nearing late career can negatively affect students’ career path choices.

**NRC Report on Climate Intervention: Reflecting Sunlight to Cool Earth**

Dr. Doney discussed the Committee on Geoengineering’s two related reports, *Climate Intervention; Carbon Dioxide Removal and Reliable Sequestration* and *Climate Intervention; Reflecting Sunlight to Cool Earth*. The term “intervention” was chosen to reflect stepping in to alleviate some aspects of an ongoing problem. The reports represent distinct issues, aspects and risks.

The motivation of the study is the growing evidence that the Earth’s climate is changing and there are impacts on people, natural ecosystems and societies, raising the question of possible solutions.

He said the most obvious of the possible climate response options is to reduce the greenhouse gas emissions that are driving the majority of the human-driven climate change. The second option is to adapt to the impacts of climate change. The third possible response is climate intervention, which is the focus of the reports.

The committee’s task was to look at two classes of climate intervention technologies:

* Removing carbon dioxide from the atmosphere
* Reducing sunlight absorbed by the Earth to cool the planet’s surface.

The committee was also tasked with looking at what is currently know in terms of:

* The science — risks and consequences
* The viability for implementation.

The committee was also tasked with:

* Identifying future research needed
* Commenting generally on potential societal, legal, and ethical considerations.

Dr. Doney reviewed the committee membership. It held four meetings and used 16 outside experts.

He said **Recommendation 1** was very strongly held by the entire committee:

* + Efforts to address climate change should continue to focus most heavily on:
		- Mitigating greenhouse gas emissions in combination with adapting to the impacts of climate change because these approaches do not present poorly defined and poorly quantified risks seen in climate intervention strateges and because they are at a greater state of technological readiness.

Focusing first on the report on carbon dioxide removal and reliable sequestration, Dr. Doney said there are two parts: A mechanism to remove carbon dioxide out of the atmosphere and finding a place to put it safely.

One approach to carbon dioxide removal is enhancing natural carbon sinks. The committee examined:

* Changes in land use management:
	+ Reforestation / afforestation – Agricultural practices
* Accelerated weathering:
	+ Chemical reactions to form carbonate or silicate minerals
* Ocean iron fertilization:
	+ Adding iron to the ocean to boost the growth of phytoplankton.

The committee also looked at more technological solution to carbon dioxide removal:

* Direct Air Capture and Sequestration (DACS)
	+ Chemical scrubbing processes
* Bioenergy with Carbon Capture and Sequestration (BECCS)
	+ Use plants (biomass) to produce energy
	+ Capture carbon dioxide from power plant and sequester underground.

**Recommendation 2** is that carbon dioxide removal is ready for increased research and development:

* The Committee recommends research and development investment to:
	+ improve methods of carbon dioxide removal and disposal at scales that matter and in particular to:
		- minimize energy and materials consumption
		- identify and quantify risks
		- lower costs, and
		- develop reliable sequestration and monitoring.

Dr. Doney moved on to the second report and began his discussion of albedo (the proportion of incoming sunlight reflected back to space) modification. The committee tried to avoid the use of the phrase “solar radiation management,” because it believed it was not possible to manage solar radiation.

Albedo modification does not get at the root cause and there is not a 1:1 match between modifying the albedo and completely reducing the effects of rising greenhouse gasses, he said.

The committee looked at two strategies:

* Stratospheric aerosols
* Marine cloud brightening.

**Recommendation 3** is motivated by the understanding that albedo modification poses significant risks:

* Albedo modification at scales sufficient to alter the climate should not be deployed at this time.

The environmental risks include:

* Decreases in stratospheric ozone
* Changes in the amount and patterns of precipitation
* No reduction of the root cause of climate change
* Poorly understood regional variability
* Potential risk of millennial dependence.

The committee found there is also a significant potential for unanticipated, unmanageable, and regrettable consequences, with political, social, legal, economic and ethical dimensions.

**Recommendation 4** is motivated by a need to provide relevant information to policy makers and stakeholders in the case, for example, of a climate emergency, or to determine if it could be part of a portfolio of responses:

* The Committee recommends an albedo modification research program be developed and implemented that emphasizes multiple benefit research that furthers:
	+ basic understanding of the climate system
	+ and its human dimensions.

Recommendation 4 is also aimed at providing a better understanding of the consequences of an action by a unilateral/uncoordinated actor.

In response to a question, Dr. Downy said the sense of the committee is that ocean fertilization is relatively small as a carbon dioxide removal strategy and there are some large known environmental consequences and it is cost inefficient in the long term.

The committee determined that current observational capabilities are not sufficient to detect and monitor the environmental effect of albedo modification deployment, were someone to start to do such modification.

This lead to **Recommendation 5**:

* The Committee recommends that the United States improve its capacity to detect and measure changes in radiative forcing and associated changes in climate

Turning to governance, Dr. Doney said the committee focused almost entirely on governance of research, not deployment. Albedo modification technology has been controversial even at small scales for stated research goals. Although there are no specific federal regulations, beyond those for scientific conduct, there is a need more a more transparent and inclusive conversation, given the skepticism in civil society. The goal of governance of research should be to maximize the benefits and minimize the risks. The committee did not feel it had the expertise on how to set up a research governance and instead determined there was need for a serious deliberative process that goes beyond federal agencies and the scientific community to talk about the types of research governance might be needed and what types of research would fall under that framework.

**Recommendation 6:**

* The Committee recommends the initiation of a serious deliberative process to examine:
	+ (a) what types of research governance, beyond those that already exist, may be needed for albedo modification research, and
	+ (b) the types of research that would require such governance, potentially based on the magnitude of their expected impact on radiative forcing, their potential for detrimental direct and indirect effects, and other considerations

Dr. Doney concluded on the following points:

* The challenges of climate change require a portfolio of actions with varying degrees of risk and efficacy
* There is no substitute for mitigation and adaptation
* Carbon dioxide removal strategies offer potential to  decrease carbon dioxide concentrations in the atmosphere
* Albedo modification strategies currently limited by unfamiliar and unquantifiable risks and governance issues
* Any intervention in Earth’s climate should be in formed by a far more substantive body of scientific research than is available at present.

Discussion. In response to a question, Dr. Doney said that because of other reports that have been produced on mitigation effects, and the time available the committee, it did not explore this issue.

Dr. Arroyo said the use of “intervention” in the title was interesting because that word is associated with addiction. But when you intervene in someone’s addiction you usually try to get at the underlying cause. For albedo and ocean fertilization, it feels like hubris, she said, to suggest we have any clue of the ultimate cost. She said the cost of those methods would not be less than mitigation.

Dr. Doney interjected that cost is a major determining factor for the carbon dioxide removal approaches relative to other approaches. But the published numbers for albedo modification are orders of magnitude lower than overhauling the global energy system.

Dr. Arroyo pointed out that California, for example, is decoupling economic growth from the use of fossil fuels and is growing the economy at the same time. If the reason the committee looked at one differently than the other is because the cost might be less to throw a bunch of stuff in the air, she said, that’s not a responsible way of looking at the whole overall cost-benefit analysis when you consider there are co-benefits from reducing the addiction to fossil fuels and many adverse effects that we can’t even hope to understand in terms of what we’re setting off here with albedo modification and ocean fertilization.

Dr. Doney responded that the committee had to use what was available in the literature. He cited literature showing there are technologies that are beneficial for the first increment but the costs later go up dramatically.

Dr. Arroyo responded that it was therefore more important to mitigate sooner to get to the low hanging fruit. But she added that people need to think about the issue because it might stimulate activity in governance and understand that it might mean not seeing sunny days or in times of war not being able to keep up albedo modification air flights and unleashing the full extent of climate change in a very rapid way. She said it was important to figure out some kind of governance strategy and recourse if an individual or nation attempts such modification efforts.

Dr. Taylor said international discussions to move to governance is a very big deal because others could decide to unitarily take such actions on their own.

Asked to speak more about the research side of international governance, Dr. Doney said the committee was not focused on the typical international coordination, except for Recommendation 5 about monitoring and observing albedo and its impacts. Governance will clearly have to have an international component but even within the U.S. it is broader than the typical research discussion. We’re really saying we need to bring to the table social groups that are very skeptical of even pursuing a research agenda. There has been discussion that even doing research is morally wrong because it can be interpreted as saying mitigation is not needed. Buy-in is needed from a much wider community.

Dr. Constable noted that these kinds of experiments are already going on by virtue of things taking place on the planet already. There is a need to study these inadvertent experiments.

Dr. Doney said the reports noted that a lot has been learned from volcanic eruptions and ship tracks, but natural analogs are imperfect.

In response to a question about carbon dioxide removal, he said that the committee report discusses direct air capture that uses a chemical stripping method. The question is whether it can be scaled up in a cost effective way.

Answering another question, Dr. Doney said the committee determined that given the current understanding of ocean iron fertilization, that is not the best place to put further investments.

Dr. Dixon said that regarding adaptation there is a huge social component that does not come through in the report.

Dr. Doney said adaptation has been covered by other studies and was beyond the committee’s purview.

Responding to a question on other greenhouse gasses, Dr. Doney said carbon dioxide was the focus because it has a very long lifetime once it is in the ocean atmosphere system and the amounts emitted.

He added, in response to another question, that the report documents current industrial uses for carbon dioxide.

A question about liability prompted Dr. Doney to say the committee documented the history and legal issues of cloud seeding, which still occurs.

**Action Item**: The next meeting will occur on October 21-22.

**Working Lunch: Open Discussion, Wrap-Up and Action Items**

Dr. Hornberger began by providing additional time for the committee to discuss the previous day’s presentation on merit review pilot projects by Dr. Meacham.

Dr. Taylor opened with a question about proponents being able to respond to peer review before it goes to panel, which is used in other countries.

Dr. Meacham said the countries that used this mechanism dealt with many fewer applications. But there are a couple NSF programs that use this process. It is found to be time consuming and there are questions about how it might work in primarily academic fields and where there is significant field work, due to programs’ requirements to balance their budget and determine which proposals will be funded well in advance of the end of the fiscal year. This can be an issue of feedback not being received in a timely fashion. There is also a fairness issue.

He added there is no NSF mandate that any pilot programs be adopted.

In response to a question about any experience in bio with pre-proposals and skepticism about the approach, Dr. Meacham said over time people have become accustomed to it. A concern going into the pilot was whether it would affect young faculty disproportionately. He said they will not be affected any worse than the status quo. The success rate is not negatively affected by the pilot. Rather it provides more opportunity to focus ideas. The Science Board has expressed an interest in whether there is any potential with using short-form proposals. One of the advantages of the approach Biology has taken is the preliminary proposals do not require a detailed budget and do not have to receive approval from the university sponsored research office, making it less time consuming for the PI to prepare a preliminary proposal. It is also easier for reviewers and focuses their attention on the main idea of the proposal.

Responding to a question about budget preparation for this pilot program, Dr. Meacham said Biology asks for a bottom line only, which is an estimate only.

Returning to PI responses to reviews as used internationally, Dr. Kempton said it works very well in the U.K., where software solutions help with the workload and where it is changing the culture of how faculty members are evaluated.

Dr. Meacham said NSF is planning to discuss this and said the impact in the U.K. has been very significant. The U.S. research community has not been engaged in a dialog of how effective they think it would be in the U.S. Each U.K. research council publishes a yearly list of proposals submitted by institution with information on awards. In the U.S. the situation is potentially different. The initial reaction in the U.K. research community was negative. That community has grown accustomed and now finds an overall improvement in the research climate.

Asked whether there are discussions about doing more virtual panels, Dr. Meacham said the effort is to analyze the experience with them to date. Factors include possibly doing training for potential panelists. NSF is planning a customer satisfaction survey for PIs and reviewers. It will include experience with virtual panels.

He said his own experience included time as a program officer that only used ad hoc review, without deadlines. If there was a question that a PI might be able to address about a proposal that would otherwise be funded, the PI would have an opportunity to address the question. This was possible because there was not the deluge of proposals some other programs had. He was also involved, he said, in special programs with an elaborate review process with multiple rounds where the panel interrogated PIs on the phone during the panel. It was effective but difficult to coordinate. He added that technology is not the obstacle.

Dr. Hodges said it was hard to imagine the community thinking this was a bad idea. Dr. Meacham disagreed, saying decisions could take months longer. Dr. Hodges said NASA uses this process successfully by having only brief responses from PIs. He added that without this input panels sometimes get the science wrong.

Dr. Faulkner said she was a program officer on a new program that went back to PIs for more information but added that doing that systematically does create a workload issue. She also raised the issue of fairness when the process is not applied systematically.

Dr. Constable suggested a limit on the amount of engagement.

Dr. Arroyo returned to pre-proposals and said her institution used short concept papers with high-level budgets, which gives a sense at a high level of whether the proposal is meeting the needs of the foundation.

Responding to a question about a review process involving the PIs and game theory, Dr. Meacham said it has only been tried once. The program officer engaged the community beforehand and it was used for a program with a semi-annual cycle. The pilot involved one of the six-month cycles. It was made clear to the community that they could participate or wait until the next cycle. There were more proposals that cycle than normal, for a total of 131, which were divided into four groups arranged by theme. Each PI reviewed seven proposals. They wrote comments on each and ranked them. The rankings were combined for a consensus ranking. PIs were told in advance that to the extent their ranking coincided with the consensus ranking, they would receive bonus points that would up their ranking. The program liked the process because it did not have to find reviewers. Also, the proposals had more reviews (seven) than normal. Also, the average length of reviews was larger than normal. But the program officer, who was happy with the process, made a mistake when, just a few days after the funding decisions were announced, he asked those who submitted proposals what they thought of the process. There was a strong correlation between what people thought of the process and the funding outcomes.

In response to a question he added this type of experiment will only work in fields where all the people in a cohort can logically be expected to be sufficiently informed to comment on the proposals. He suggested that more experiments were needed.

Dr. Meacham concluded by suggesting to the committee that if they had ideas for pilots, they should have more dialog with Geosciences. Dr. Wakimoto added that the division directors would appreciate the suggustions.

Dr. Hornberger continued the final session of the meeting by taking questions from the committee, which primarily concerned agenda items for the next meeting. The following topics were proposed:

* Dr. Taylor suggested that ICER be included on the agenda for the next meeting, adding that the committee has not engaged sufficiently at the directorate level. Dr. Wakimoto agreed it should be on the agenda and encouraged discussions across directorates as well.
* Dr. Constable suggested that there be more focused discussion at a future meeting on cyber infrastructure. Dr. Doney followed up on the issue of cyber infrastructure with a reminder of an EarthCube meeting in May and suggested the committee receive a report at its next meeting.
* Dr. Voorhees added a suggestion for future discussion on the education implications of GEO and how it interacts with EHR.
* Dr. Dixon raised the issue of archiving physical objects and said it was time to address this problem in a systematic way.
* Dr. Hodges suggested for the next meeting a conversation about getting something EAR-related that would be a comprehensive document to centrally determine what the community thinks about priorities.

Dr. Wakimoto summarized the discussion and said NSF would share information about INCLUDES at the next meeting. Also, he agreed to include cyber infrastructure on the agenda. Regarding education, he said he could reach out to the AD for EHR.

Dr. Taylor said the committee has had issues with EHR presentations to the committee. He suggested an intermediary to understand the revised playing field.

Dr. Wakimoto said that was possible, though he added that EHR has been more inclusive about understanding discipline-specific issues. He suggested doing both EHR and an intermediary.

Regarding the directorate-wide perspective, he said he would appreciate the committee’s advice, adding he’d liked to know what kind of information the committee would like to hear from NSF.

The topics mentioned will make for a full agenda and might have to be prioritized, he added. He also said a subcommittee was needed to plan the agenda.

Dr. Taylor said for the October meeting the subcommittee meetings could be held concurrently.

Dr. Wakimoto said he had been advocating this with the division directors. He would like to reserve the meeting of the whole committee for when it is necessary to meet face to face. Other items, he said, are suitable for virtual meetings. He suggested making the in-person subcommittee meetings as short as possible.

Dr. Hornberger closed by soliciting ideas anyone might wish to offer for the AGI critical needs document.

He thanked everyone for attending and adjourned the meeting.