

64th Meeting of the NOAA Science Advisory Board
April 23-24, 2019

Location: Hilton Garden Inn
2201 M Street NW
Washington, D.C.

Presentations for this meeting have been posted on the Science Advisory Board (SAB) website:
<http://www.sab.noaa.gov/SABMeetings.aspx>

SAB members in attendance:

Ms. P. Lynn Scarlett, Vice President for Policy and Government Relations, The Nature Conservancy (Chair); Dr. Michael J. Donahue, Vice President and Director, AECOM ; J. Walter Faulconer, President, Strategic Space Solutions; Dr. Robert Grossman, Frederick H. Rawson Professor and Jim and Karen Frank Director, Center for Data Intensive Science, University of Chicago; Dr. Everette Joseph, Director, National Center for Atmospheric Research (NCAR); Dr. Eugenia Kalnay, Distinguished University Professor, Department of Atmospheric and Oceanic Science, University of Maryland; Mr. W. Christopher Lenhardt, Domain Scientist, RENCI University of North Carolina Chapel Hill; Dr. Denise Reed, Professor Gratis, Pontchartrain Institute for Environmental Sciences, University of New Orleans; Dr. Robert Rheault, Executive Director, East Coast Shellfish Growers Association; Dr. Martin Storksdieck, Director, Center for Research on Lifelong STEM Learning and Professor, College of Education and School of Public Policy, Oregon State University; and Mr. Robert S. Winokur, Consultant (ret. NOAA, Navy).

NOAA senior management and Line Office representatives in attendance:

Dr. Neil Jacobs, Assistant Secretary of Commerce for Environmental Observation and Prediction, performing the duties of the Under Secretary of Commerce for Oceans and Atmosphere; RDML (ret. USN) Timothy Gallaudet, PhD, Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy NOAA Administrator; Mr. Craig McLean, Assistant Administrator for Oceanic and Atmospheric Research; Mr. Kevin Wheeler, Deputy Chief of Staff for Policy; Dr. Gary Matlock, Deputy Assistant Administrator for Science, OAR; Dr. Steven Thur, Director, National Centers for Coastal Ocean Science, National Ocean Service; Ms. Mary Erickson, Deputy Assistant Administrator, National Weather Service; Dr. Stephen Volz, Assistant Administrator, National Environmental Satellite, Data, and Information Service; Dr. Cisco Werner, Chief Science Advisor, National Marine Fisheries Service; Dr. Ned Cyr, Director, Office of Science and Technology, NMFS; and Dr. Ed Kearns, NOAA Chief Data Officer, Office of the Chief Information Officer.

Staff for the Science Advisory Board in attendance:

Dr. Cynthia Decker, Executive Director and Designated Federal Officer; Ms. Elizabeth Akede; and Ms. Caren Madsen.

April 23, 2019

Opening Statement of the Chair

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett welcomed the attendees to the meeting and highlighted the decision items for the Board on the day's agenda.

SAB Consent Calendar

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

- February 2019 SAB Meeting Minutes
- Working Group Status Reports

Bob Rheault made a motion to accept the items on the consent calendar; Mike Donahue seconded the motion, and it passed unanimously.

NOAA Update

RDML Timothy Gallaudet (USN, ret.), Assistant Secretary of Commerce for Oceans and Atmosphere and Deputy NOAA Administrator

Summary

RDML Gallaudet began by acknowledging the passing of Dr. Walter Munk, Scripps Institution of Oceanography, and briefly discussed his legacy in and beyond NOAA. NOAA has increased its engagement with OSTP (Office of Science and Technology Policy) and Director Kelvin Droegemeier, who has been a major proponent of NOAA for years. Dr. Droegemeier has put forth his vision for a second bold era of research and development, and NOAA will move forward in working with OSTP to achieve this goal. With RDML Gallaudet taking on the role of NOAA Chief Scientist, his team has identified four focus areas that will enable science in ways that will be transformational. These are:

- Earth system modeling. Computational advancements and increased environmental understanding have improved the capability for next generation modeling. The HWRF (Hurricane Weather Research and Forecasting) model has shown a seven percent improvement over the earlier version and outclassed the European model in forecasting Hurricane Maria.
- Unmanned systems. The FY2020 budget includes a plus-up for establishing an operational office within OMAO (Office of Marine and Aviation Operations) for unmanned systems (UxS). This office envisions UxS as infrastructure and will partner with the Navy and Coast Guard.
- Artificial intelligence and machine learning. Finding ways for Line Offices to work more collaboratively in this area is going to be the key to harnessing this great opportunity.
- 'Omics/eDNA (environmental DNA). Next generation gene sequencers have made many things possible without having to kill fish or invest in the larger amounts of ship time needed for traditional surveys. NMFS (National Marine Fisheries Services) has developed a road map for work in this area and will continue to advance its use for protected species assessments, fisheries stock assessments/management, and ecosystem restoration and monitoring

Blue Economy Update

Marine transportation is a major component of the blue economy initiative. Using more data science applications to improve the efficiency of disseminating this information will improve the

nation's seaports and coastal economies. The National Marine Sanctuaries are doing a lot of great science on ecosystems, coral reefs, and marine archaeology that also supports the tourism and recreation industries. Their work on road stabilization has also provided immense benefits to coastal communities. NOAA is working to improve its science of stock assessments to aid in making the nation's seafood industry more competitive with the rest of the world. eDNA will help in this regard, as well as reducing regulations to allow for more access in a sustainable way. The Seafood Inspection and Monitoring Program is helping to curb fraudulent imports and increase U.S. seafood exports. NOAA's ocean exploration mission is advancing not only in opening access for information for sustainable offshore development but also scientific discovery. Among other finds, NOAA teams discovered 25 new marine species last year, and American leadership in this area is something the administration wants to maintain.

The Pacific Ocean and Pacific Islands are taking on a renewed focus by the White House, and NOAA has a large role to play, not only in advancing fisheries but in mapping the U.S. EEZ (exclusive economic zone) and potentially taking over charting authority for non-U.S. held areas of the Pacific. This effort is meant to underpin resilience activities that require this foundational information. NWS will also have a big role to play in this as these islands receive a good deal of extreme weather.

Discussion

John Snow, co-chair of the SAB Environmental Information Services Working Group, asked about recent developments with the Papahānaumokuākea Marine National Monument off the coast of Hawaii. RDML Gallaudet said that they help manage the area by conducting annual marine debris cruises. The monument is the site of many cultural and historic resources that the agency preserves and documents. Lynn Scarlett added that the monument is jointly managed by the Fish and Wildlife Service and NOAA. There is a resource management plan that guides the considerations of the agencies. With the expansion of the monument during the Obama administration, she assumed that this plan was updated.

Bob Grossman said that one of the biggest issues with machine learning is getting the data into a form and repository in which the people who need it can use it. He asked about NOAA's intentions for improving access to its rich collection of data that is still challenging to get. RDML Gallaudet said the satellite capabilities are opening up vast arrays of data and has led many NOAA scientists to consider how best to work with it. Acting NOAA Administrator Jacobs has experience with the private sector and has plans for the use of cloud computing resources to make NOAA data more usable. Partnering with other federal agencies, such as the Department of Energy, will open up many other opportunities in this area.

Bob Rheault encouraged the agency to consider the tremendous opportunity and appetite for aquaculture development in the Pacific. Because there are no state waters on the west coast and no agency to grant permits in federal waters, they are precluded from participating in aquaculture development. He asked if there has been any discussion of Executive action to resolve this challenge. RDML Gallaudet said NOAA is in talks with the Department of Commerce, the Council on Environmental Quality, and the White House about this and they will continue to pursue it..

Martin Storksdieck asked how NOAA views its role in addressing the issue of plastic and micro plastics in the oceans. RDML Gallaudet said NOAA runs a marine debris program that was reauthorized last October. Some new provisions include working with other countries to build capacity for waste management, tackling marine plastics at the source. NOAA also has clean-up capabilities and has several ships involved in these efforts every year. Their efforts include outreach, educating the public, schools, and others on trying to be good stewards. There is also science and one of the seven areas that the National Oceanographic Partnership Program (NOPP) wants to focus on is marine plastics – finding new alternatives to plastics as well as new approaches to clean up plastics from the ocean.

Lynn Scarlett asked, as NOAA broadens ocean explorations partnerships to include more private sector partners, what is NOAA's thinking on: (1) data management and access, (2) ensuring continuity of purpose over time that links to NOAA's mission, and (3) ensuring that wholly public benefit projects that would not be profitable to private entities are continued. RDML Gallaudet said NOAA will maintain core services in-house while having other capabilities performed by the private sector, which has more efficient solutions for handling them. Research computing advancements is the area where he sees the largest opportunity for partnering with industry on AI and machine learning.

Everette Joseph asked for more information on NOAA's strategy for exascale computing and who in NOAA would be early adopters of the technology. RDML Gallaudet said Dr. Jacobs could better answer that question later. Bob Grossman followed on by asking about the role NOAA will play in the large-scale infrastructure needed for machine learning and AI. RDML Gallaudet said they do not yet know if the Department of Energy is going to be able to compute weather modeling for NOAA. This is why they want to have discussions with them now, to help shape and influence the development of the architecture, as it will affect the code they use for new model implementation.

Sustainable Marine Aquaculture Presentation

Bob Rheault, East Coast Shellfish Growers Association and SAB Member

Summary

NOAA's Draft Strategic Aquaculture Science Plan (SASP) was released in mid-April. The Topic 6 team will receive input from the MAFAC (Marine Fisheries Advisory Committee) Aquaculture Task Force on industry priorities. The team hopes to have their review of materials complete by May and send their comments to the SAB by early June. At the June 18 meeting, the SAB will decide what input to provide to the SASP. Progress was slowed due to the government shutdown, but a review of NOAA's aquaculture portfolio was completed.

Discussion

Lynn Scarlett asked if the Topic 6 team would be reviewing the MAFAC priorities themselves and/or figuring out ways to advance and implement whatever the priorities are. Dr. Rheault said their intention is not to redo the work of the MAFAC task force, but rather to make recommendations about the science of doing science and how best to achieve the goals. The

question is how do the agency take advantage of the resources it has and focus them in the most efficient way possible? Chair Scarlett followed up asking if Dr. Rheault had a sense or could give a brief summary of what the MAFAC task force research priorities are. Dr. Rheault said it is a laundry list of priorities on a vast array of topic areas. These are experts that have done a lot of hard work to identify key topic areas for NOAA's scientific portfolio to pursue in order to push aquaculture forward. Cynthia Decker will disseminate the draft SASP to the SAB members when it is available.

Chris Lenhardt asked if upstream issues, such as sedimentation flows into estuaries that might affect aquaculture, are being considered. Dr. Rheault said they are very focused on near-field impacts of things like climate change and increased frequency of large rain events. There are also permitting challenges, sociological challenges, and genetic challenges. The U.S. aquaculture industry has figured out how to do this sustainably, and they are poised to step it up.

Craig McLean said the Sea Grant program currently houses the largest amount of resources within NOAA on the science of aquaculture and where/how they make investments could be very helpfully guided by the results of this study. He suggested the team consider if NOAA would benefit from having regional aquaculture centers where new ideas could be tried out. He hopes that that model or other possibilities that would be different from what they are doing today could be evaluated during the course of the team's review.

David Helms asked via webinar if NOAA will provide shellfish prediction. The Chesapeake Bay had a large blue crab recruitment drop in 2019, and Virginia and Maryland are struggling to update. RDML Gallaudet said he didn't think NOAA routinely provides shellfish production prediction estimates. The agency is working to improve its longer-range seasonal and sub seasonal environmental prediction capabilities of rainfall events, ocean conditions, and weather conditions, which are drivers for shellfish production and fisheries management. Once the agency has improved these pieces, NOAA will be prepared to begin biogeochemical modeling, but this is a few years out. Dr. Rheault said he believed there are too many variables to properly model oyster populations from weather data.

Introduction of the NOAA Research and Development Plan Outline

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Gary Matlock, NOAA Oceanic and Atmospheric Research

Lynn Scarlett provided background on this follow-up to the SAB's previous discussion on the Research and Development (R&D) Plan outline. The goal of the discussion was to further discuss the comments SAB sent to NOAA and agree on how to provide NOAA consensus input on the outline. The SAB will receive a draft of the plan in time to comment on it at their June meeting.

Gary Matlock discussed the development of NOAA's third R&D Plan. Each of these plans cover a five-year period, and the previous one has expired. He was very grateful for the efforts the SAB put into preparing their comments on the draft. The purpose of the R&D Plan has been to make clear what NOAA's R&D enterprise is trying to accomplish, how the pieces fit together, what the roles are, and how things are conducted. It was not conceived as being a strategic plan,

implementation plan, or road map, but simply to inform readers of what NOAA's corporate R&D enterprise is. They are extending the period of this plan to cover 2020 through 2027. The plan's development team used the format of previous plans combined with the primary objectives of NOAA leadership, improved forecasting pursuant to the Weather Act, the Department of Commerce's Strategic Plan, Executive Orders and Congressional mandates, OSTP priorities, and other materials to form a sparse outline, then solicited comments through the Federal Register. Those comments have been incorporated into the draft R&D Plan, which has gone on to NOAA's Research Council. Once it is approved it will go to the NOAA Executive Panel and the NOAA Executive Council to be approved by the Under Secretary. The target for a finished document is September 2019. The SAB will receive the second draft which will include the consideration of their comments and internal NOAA feedback. They will also receive further comments from the SAB in July. This guidance document will feed into NOAA's Annual Operating Plan. The team used the President's requested NOAA budget for the next five years to craft the document, though they recognize this an uncertain figure.

Discussion

Lynn Scarlett led the discussion and reminded SAB members that they will have further opportunities to provide input on the document before it is final. The focused comments from this session were intended to help shape the draft version in key areas.

Martin Storksdieck had compiled a clustered document of the SAB's previous comments to the R&D Plan outline. He reviewed this document and cautioned that he was largely conveying his understanding of the comments rather than speaking for the Board. The comments had to anticipate where the outline is headed rather than how it appeared, and Board members described what they would like to see. The SAB emphasized the importance of how NOAA positions the report when it comes out and of making clear what the nature of the report is. Comments included illuminating the role of big data and social science in the research NOAA should be conducting. Members also suggested the report be more explicit about the broader systems approach.

Gary Matlock said that the NOAA group drafting the R&D Plan have been discussing the issue of the nature of the document. It is still a conundrum to the writers because they are trying to be responsive to a 2004 review. Coupled with this issue is the question of who the audience is going to be. Dr. Matlock expected that the final version will either have social sciences compiled in one research area or they will be inserted throughout in a way that is not duplicative. He would like the SAB's feedback on whether or not they accomplish this in the draft version. Another issue raised in the SAB comments was whether or not to incorporate an emphasis on climate. NOAA is driven in the climate arena by federal laws that require them to do research on climate. They have received support throughout the Department of Commerce to do this and to continue to produce documents that reflect the results of that research. Dr. Matlock expects that this will be the case with the R&D Plan. If the next iteration of the plan does not adequately reflect climate issues, the SAB's feedback would be very helpful. Dr. Matlock agreed with the comments that the writers have not addressed the development side of R&D with the same zeal they show for research. NOAA does a lot of development but does not articulate it in a way that the

significance of what they do is recognized. They will try to better highlight the research-to-operations efforts within the agency.

Lynn Scarlett discussed overarching thematic research considerations, such as the importance of social sciences in many of the endeavors that NOAA undertakes. She suggested considering the inclusion of a section on cross-cutting themes at the beginning of the document to highlight bodies of research that are infused and integrated throughout NOAA's work, without having to repeat them in every section. Another issue is in the way the document is structured into three Vision Areas with a series of questions. This obscures the importance of transdisciplinary research and the integrated systems lens through which NOAA should be looking at the questions. Addressing this at the beginning of the document might be a way to work this in. Climate is another cross-cutting issue that could be addressed at the beginning of the plan. This is not to say that the plan should not go into more detail elsewhere, but it would prevent the appearance of ignoring the issues, confining them to one place, or being repetitive.

Bob Winokur said that the plan does not need to identify specific elements of the budget, but without recognizing in some way that there is a budget makes the plan look like an unconstrained document, which is not realistic. He also requested that NOAA provide their rationale for not incorporating the SAB's comments which are left out of the plan so they don't keep reiterating the same ideas.

Bob Rheault asked for clarity on who the target audience is intended to be. Dr. Matlock said it is both a public-facing document and an internal document that can provide anyone with an interest in the agency's R&D efforts information on what the enterprise looks like. Previous versions have been widely distributed, turning up in media reports, on Capitol Hill, in classrooms, etc. Making it as broadly available as they can is always the intent.

Walt Faulconer encouraged NOAA to write the plan with a clear sense of how they intend it to be used and by whom. Martin Storksdieck added that his preference would be to have NOAA people specifically in mind when writing so that they know where the agency is going. The writers should consider the team composition of NOAA efforts, including the writing of the plan. It is a visionary document about how scientific research should be done in the 21st Century. Bob Winokur said his view is that this document is going to be most useful for internal planning, for an investment strategy, and will be important for articulating that investment strategy to Congress and OMB. Since these are the people that will have to execute on this plan/strategy, the focus should be on them as the audience.

Denise Reed said there is a danger of just reiterating the stovepiping within NOAA. Where the Vision Areas are articulated as societal impacts there has to be some element of understanding societal impact and that there is a science of that. She encouraged NOAA to think about how they can put together a document that shows how to structure research so that, while discrete pieces may need to be studied separately, it can be done in such a way as to connect those research findings to help people on the ground that are encountering many concurrent issues. Chris Lenhardt suggested two more cross-cutting themes to be addressed in the plan: (1) data – not just access but also science questions related to data interoperability, and (2) team science – research on how to facilitate transdisciplinary science that NOAA might want to consider in this

context. Martin Storksdieck said there is a National Academy report on team science that could be helpful.

Lynn Scarlett said structuring the R&D Plan around a series of questions (and only around a series of questions) misses the really big picture. Interconnections and complexity are increasingly important in the research enterprise and in the kinds of challenges it tries to address. As human impacts on earth systems occur and grow, the social-physical world interfaces become increasingly prominent and challenging. The plan could address how NOAA seeks to understand and manage those interfaces and generate science that helps to manage them in ways that better enable us to, for example, reduce impacts to communities of severe weather. Also, the challenges and opportunities of managing big data, ensuring its access and quality, as well as meaningfulness, are very important at this juncture. It would be helpful if the R&D Plan began with a picture of how the world looks and a description of some of these major driving features that relate to NOAA's mission, their R&D enterprise, and the questions they are trying to provide some illumination on. After that, one can dive down into the details of more discrete Vision Areas and questions.

Bob Winokur said he did not care for organizing the plan in the context of questions, but would prefer simple declarative statements of what the program is about and having everything flow from that. The goal of the R&D Plan should not just be to answer the questions, it should be to provide key capabilities within certain timeframes and to characterize the end state they are working towards.

Stephen Volz said that without any prioritization metric or methodology the plan is a wish list, which raises issues of its utilization. An appendix that states how it is supported and how budget priorities are reflected in research priorities would be helpful. The outline was structured so as to incorporate touchstones from the administration into elements of the plan, but it is missing the overarching component of integration. Framework compatibility and data interoperability are being implemented across NOAA operations but are not built into research activities at NESDIS or elsewhere. Some of the integration is difficult, and there is not a ready solution, but stating the objective is a useful and important piece of the plan.

Mary Erickson said that if the plan was prioritized and focused by key principles and themes, it would be a great benefit to NOAA internally because of the thorough vetting process it goes through. Having a vetted strategic path forward would provide focus for direction in research projects and focus for solutions from an operational perspective. Enterprise partners would also have a guide to where NOAA's work is going and how it aligns with the work they are doing, helping them to better pitch the agency on projects and products.

Gary Matlock spoke to the comments on identifying who the audience is. This is a very challenging question for them as they do not want to exclude audiences. Once the document is available for public comment, he expects they will find out if any interested parties have been overlooked. Lynn Scarlett said it is a matter of keeping in mind who NOAA wants the key audiences for the document to be in order to give it shape.

John Snow said he understands this to be primarily an internal document where “internal” is broadly writ to include Cooperative Institutes and other partners. He did not recommend writing it for a broad audience, but rather to get the document done, and if it is necessary to convey it to a different audience, provide a brief, tailored summary upfront and send it to them.

Paul Knight said there are so many things going on that it is difficult to wrap one’s arms around it all. Narrowing down the items covered to what is realistic and attainable in a six or seven-year period could be helpful. Since it is just a plan, NOAA will have the opportunity to refine it later.

Lynn Scarlett suggested as a path forward that the SAB combine the clustered comment document and the minutes of this discussion to send to NOAA. Martin Storksdieck said a summary of the general principles that came out of the discussion would provide broader guidance on what to do with the report. The SAB will then be able to see to what extent those principles are reflected in the draft. Mary Erickson said that organizing the comments under the guiding principles of this discussion made sense, but since Dr. Matlock will have to convey them to a set of people who were not present for the discussion, it would be helpful to provide context by simply extracting it from the minutes. Lynn Scarlett modified the suggestion to say that the excerpt from the minutes will be circulated to SAB members to ensure that they accurately captured the discussion, but that members will not rewrite anything. This will then be sent to NOAA as the Board’s feedback.

Walt Faulconer said that it is important that the SAB receive a formal explanation from NOAA on which comments they incorporated into the draft, which they didn’t, and why.

Denise Reed asked if NOAA has the principles that were brought up during the discussion that they can draw from. Dr. Matlock said they do have them scattered in different documents, some of which may not be currently operative. Having the principles from the SAB that they think should be articulated in the plan would be worthwhile, but they do not need much detail. NOAA can use the minutes and notes from others in the writing group that were present for the discussion to decide how to use them in the draft.

Presentation on the Environmental Information Services Working Group Report on the Use of Observing System Simulation Experiments (OSSEs)

Xubin Zeng, University of Arizona and EISWG Member

John Snow, University of Oklahoma and EISWG Co-Chair

Eugenia Kalnay, University of Maryland and SAB Member

John Snow introduced the presentation. The SAB had previously identified a need for consideration of observing system simulation experiments (OSSEs) as part of its biennial Work Plan and tasked this to the EISWG (Environmental Information Services Working Group). EISWG set up a subgroup to do this with Xubin Zeng leading the effort and Eugenia Kalnay as the SAB champion. Despite the government shutdown, the group was able to review the use of OSSEs in NOAA, NASA, and elsewhere and developed options for NOAA to consider current and future R&D in this area. The working group’s white paper was distributed to Board members and is available on the SAB website. At the EISWG’s next meeting in June, they will review the

report and may develop further recommendations to forward to NOAA pursuant to the Weather Act.

Xubin Zeng reviewed the progress of the working group and presented their final report on the use of OSSEs. He discussed the current NOAA capability as represented by the different components of the OSSE system at NOAA/AOML. This group has conducted numerous nature runs, observation simulations, quantitative assessments, and established verification metrics in alignment with NOAA weather forecasting practices. In contrast to the traditional OSSE methodology that NOAA uses, the Navy utilizes what is called the historical approach because they lack the human computing resources and expertise required for traditional OSSEs. The historical approach substitutes alternate models/references combined with the historical record for the nature run. Based on the findings of the white paper, the working group has developed a set of recommendations on potential NOAA actions related to OSSEs:

- Use OSSE, OSE (observing system experiments), FSO (forecast sensitivity to observations), and EFSO (ensemble FSO) synergistically.
- Accelerate the development of OSSEs for earth system models (ESMs). This requires ESM nature runs of 3-5 km, and may require the purchase of new high-performance computers or partnership with other agencies.
- Explicitly consider the potential impact of deficiencies in current data assimilation and prediction systems when using OSSEs to evaluate observational networks likely decades ahead.
- Expand the use of OSSEs:
 - Assess the value of NOAA partnering with foreign agencies and the private sector for satellite remote sensing
 - Find the optimal way to address forecast questions (e.g., sea ice prediction)
 - Compare the value of (polar, geostationary, small/cube) satellite network strategies for weather and climate prediction
 - Perform gap analysis (e.g., what are the greatest new observational needs?)
- Extend OSSEs to societal impacts by seeking synergy with the existing NOAA Observing System Integrated Analysis (NOSIA-II).

Discussion

Eugenia Kalnay was pleased that EFSO was included in this discussion, as it is a very efficient and cost-effective way to estimate if each observation is beneficial or detrimental. EFSO will provide significant improvement to OSSEs when used with proactive quality control.

John Snow noted that NOAA is unique among federal agencies in their dependency on what they do with data. They spend large amounts of resources collecting all sorts of information from around the planet and often without understanding exactly what the influence of these data points are. OSSEs are not the only tool to help improve the design of observing systems, but they are a good way to quantify some of the impacts of what NOAA resources.

Neil Jacobs said proactive quality control is critical for observing systems and NOAA is examining several different data assimilation options. NOAA is required by law to conduct an OSSE before procuring any instrument that costs more than \$500 million, but it is also

reasonable to do one for less costly instruments as it is a relatively inexpensive procedure. NOAA is also running real-time EFSOs with the current 4D EnVar (four-dimensional ensemble-variational) data simulation system and examining the observation impact in their operational models. Cost-benefit analyses for observing systems show these to be very beneficial. Surprisingly, some of the more expensive observing systems don't provide the same amount of impact as less expensive ones. Any OSE, FSO, or EFSO is subject to the constraints and limitations of the data simulation system and the model. NOAA is currently trying to figure out how to prepare in advance for getting data from satellite instrumentation versus launching it into space, getting the data, and then figuring out how to use it. They have been successful in simulating the data in advance in order to reduce development time once the instruments are reporting data.

Martin Storksdieck asked if there was anything controversial or particularly difficult about the proposed recommendations. Dr. Zeng said that OSSEs for earth system models are not easy to construct, but the team recommended that NOAA take leadership in their development. Dr. Jacobs commented on the importance of simulating the error of the observing system properly.

Steve Volz asked for clarification on recommendation three and what is meant by “consider the potential impact of deficiencies in the simulation.” Dr. Zeng said this implies several things. First is simply the awareness of the issue. Second, they can look to other operational centers and find out if NOAA has the best available capabilities and what difference improved capabilities would make for the simulation’s accuracy.

Bob Winokur made a motion to accept the report with a minor revision to be inserted by Eugenia Kalnay regarding EFSO; Walt Faulconer seconded the motion. The motion passed unanimously.

Presentation of the Environmental Information Services Working Group Annual Report to Congress

John Snow, University of Oklahoma and EISWG Co-Chair

John Snow reviewed the background of the EISWG’s report to Congress which is required by Public Law 1525. The EISWG is attempting to find a process that meets the spirit of the law without being too burdensome. They have put in place a system where they react to reports and prepare comments and perhaps recommendations on NOAA reports for the previous year, but the reports have been slow in coming. The EISWG now has the first substantive report that has worked through the system, which focuses on improving severe weather prediction. At the next SAB meeting, the EISWG will propose a slate of new members, which will slightly enlarge the working group in addition to replacing members that have cycled off. Challenges affecting the EISWG’s ability to effectively carry out its role include FACA (Federal Advisory Committee Act) rules and regulations, the small size of the working group, the limited amount of staff support, and infrequent face-to-face meetings. Dr. Snow presented the tentative outline for their 2019 report, consisting of an introduction, an overview of EISWG actions since March 2018 relative to the Weather Act, their plans for moving forward in 2019, the OSSE report, and an identification of prioritized areas from the Weather Act on which the EISWG will focus in 2019-2020. The EISWG expects to have a report for SAB’s consideration by late June. They also expect to be more proactive this year and will focus on three key topic areas: the Hazard

Simplification Plan, the Hurricane Forecast Improvement Program, and improving seasonal and sub seasonal forecasts. Now that the EISWG has the OSSE report, they will explore the work that has been done and may make some formal recommendations.

Brad Colman noted the pivot that the group took in response to the SAB's suggestion to prioritize topics where the EISWG could add the most value and where they wanted to inform the SAB on what they felt was the core of the Act.

Discussion

Lynn Scarlett asked for clarification on the language of the Act and its requirements for commenting on NOAA reports. Dr. Snow said it does not specifically require that but says they shall transmit to the SAB for submission to the Under Secretary a report on the progress made by NOAA in adopting the working group's recommendations. If the EISWG is going to be proactive in this process, they must get to the point where they actually make recommendations that are of value to NOAA, and they have been trying to come to a situation where they are making recommendations based on looking at what NOAA is doing with regard to the rest of the Weather Act.

Lynn Scarlett asked if the SAB should expect that the EISWG will look at one or all three of the key focus areas and make recommendations to the Board, which would in turn be transmitted to NOAA. Dr. Snow said these are the areas they will focus on and will consider possible recommendations. For the near term, they will be looking very carefully at both the OSSE and tornado reports.

Martin Storksdieck asked for clarification on whether the EISWG would be making recommendations and then reporting back to the SAB on how NOAA responded to the recommendations. Dr. Snow said that was correct; his understanding of Congress' intent was to have an independent body make recommendations. The EISWG will do this and then assess what NOAA has done and advise Congress through the SAB on the situation.

Dr. Jacobs commented that Taylor Jordan, the House Science Committee staffer who wrote most of the Weather Act, is now his senior policy advisor in the Office of the Under Secretary. He can easily be reached if any clarification is needed on the intent of the legislation.

Mary Erickson said the process the EISWG went through for the OSSE report was very productive but that drilling in on a couple of substantive topics would be a very large undertaking. She suggested that EISWG making recommendations, such as potential priorities or the timing of different advances, would be very useful. She didn't think focusing too much on the reports would be the most fruitful use of their time. Dr. Snow said that, of the 42 reports, many are administrative matters to which the EISWG will not devote much attention. Some, however, should be substantive, such as the tornado report, and he expects the EISWG will have comments on it.

Martin Storksdieck asked how the EISWG will operationalize the concept of making progress on recommendations, in terms of NOAA's accountability. Dr. Snow said they have not yet

determined this, but when they frame a recommendation it should have something in it that is checkable. Chair Scarlett added that when the SAB presents a report or recommendations to NOAA, NOAA needs to explain what they did or did not do and for what reasons; there needs to be a mechanism for this kind of checkpoint.

Bob Grossman asked if the EISWG plans to make recommendations for simplifying the process and reporting. He also asked Dr. Jacobs if Taylor Jordan might have recommendations on streamlining the process. Dr. Jacobs believed Mr. Jordan would have recommendations and he also knows who the reports' audiences will be, as well as whether they will read them and take action or not. He said he would rather have people in NOAA advancing the work instead of writing reports on the work. He does want everyone to see the great work that NOAA is doing but does not want this to become a major distraction. Chair Scarlett said she believed focusing on a few content-rich, publicly important, and operationally significant topic areas is a good approach. Dr. Colman said they can continue with this approach in the absence of reports and make good progress with recommendations for NOAA. He does not want to dismiss any reports without some additional conversation because they were included in the Weather Act for a reason.

SAB members had no comments on altering the proposed outline of the report.

Public Comment

There was no public comment.

April 24, 2019

Welcome

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett welcomed everyone to the second day of the meeting.

Enhance Strategic Investment and Use of Unmanned and Autonomous Systems Presentation

Bob Winokur, Consultant and SAB Member

Bob Winokur presented a notional outline for a NOAA UxS (unmanned systems) Strategic Plan. The plan's scope includes unmanned aerial systems (UAS), unmanned marine systems (UMS), data and cybersecurity, and the supporting infrastructure. The primary goals of the plan include the expansion of operations, increasing partnerships, increasing capabilities (personnel and facilities), understanding the current state of UxS activity within NOAA, and the roles and responsibilities of the parties involved. NOAA's investment in these vessels is not directed towards development of the systems, but in the R&D for the applications of the systems. There are many ongoing efforts in this area to which the team can refer. These include the 2015 NOAA UxS Roadmap, a UAS Policy and Handbook, UAS and UMS symposium proceedings, current systematic UxS operations, and partner facilities. The current goals for NOAA's UxS programming include reducing the cost per observation, improving access to environments where it is unsafe or inefficient to make observations using traditional techniques, and quickening the pace of transitioning UxS to operations when supported by a business case, such

as NOAA's hydrographic surveys. The team plans to have a final draft available by the fall SAB meeting. OMAO's Standing Review Board is working on their fleet plan and is available to assist as desired by the SAB. There is legislation in place that directs NOAA to work with industry, the Navy, and academia to coordinate investment and operation. This act (CENOTE, Commercial Engagement through Ocean Technology Act of 2018) also authorizes co-location and is a key driver that needs to be considered in this plan. The Coast Guard has been directed to work with the Marine Board to develop an acquisition plan for UxS. Challenges for a NOAA UxS Strategic Plan include making the plan consistent with legislation and aligned with existing investments, coordinating with external partners, and informing future planning and actions.

Discussion

RDML Gallaudet said this will help to shape the way ahead for NOAA's approach to UxS. He will soon begin working with a detailee from OMAO to develop a strategic implementation plan so that when NOAA receives FY2020 funds they will be ready. NOAA will be considering options for co-location with the Navy to see where it might make sense. CENOTE will also allow NOAA to make better use of the Navy's vast capabilities, perhaps integrating with the Navy's Glider Operation Center or using the NOAA National Data Buoy Center as a situational awareness asset to track and monitor systems. The centralized certification training acquisition will be housed in the OMAO office that will be created. RDML Gallaudet discussed other possibilities NOAA is exploring for the use of UxS, and the agency hopes to have a report by the end of 2019. NOAA is also looking to expand its relationships with the Coast Guard who received a plus-up in the FY2020 budget for UxS. They intend to put UAS on all of their large cutters, which would provide a great way to perform two missions with one asset.

Bob Winokur said large shipping companies are looking into autonomous operations for container ships and this is something the SAB should keep track of. They should also consider the AI aspect of UxS and how artificial intelligence feeds into the systems.

Cisco Werner discussed a survey NMFS conducted recently in the Antarctic that was operated remotely from La Jolla, California, using satellite imagery to navigate through icy conditions. One of the major advantages he sees for these vessels is getting into areas that are inaccessible or not cost-effective. John McDonough added that he's expecting to see significant progress in the transitioning of some of these technologies to full operations, as well as more integrated operations of UMS, OAS, and ships working in tandem to collect a wide variety of data in one operation.

Steve Thur said eliminating mother ships will be the next big step for some operations. Operating UxS from land is already being done for certain applications, and this has implications for the allocation of large assets. He asked if this plan will address workforce needs associated with the expanded adoption of unmanned systems, in particular the skills that will be needed that NOAA currently does not have and the impact on employees with skills that may be rendered obsolete by increased use of these systems. Dr. McDonough said they will be considering these things as they look forward.

Chelle Gentemann, chair of the SAB Data Archive and Access Requirements Working Group (DAARWG), discussed the joint NASA-NOAA campaign in the Arctic using five Sairdrones. An advantage of their model is that the agencies do not need to create an internal UAV group or

control the vessels, they just decide on a science plan and Saildrone operates it. The government doesn't own or maintain any equipment or provide staffing. Dr. Gentemann also described other campaigns underway on suborbital (NASA's S-Mode project) and air-sea interactions (ATOMIC, Atlantic Tradewind Ocean-Atmosphere Mesoscale Interaction Campaign). She recommended connecting with these projects to understand how to best utilize NOAA's assets as they move forward. She also said that NOAA has the best format guidelines for UAV data and that others need to be updated to take advantage of the way that some of the modern programming languages have advanced. This may be a topic for to take up if the SAB is interested. Dr. McDonough said the team working on the plan includes representatives from NCEI (National Centers for Environmental Information) to address issues around data management and cybersecurity. He wanted to include them at the outset rather than having them react to it later on.

Lynn Scarlett asked how Mr. Winokur's team will avoid duplicating the efforts of Dr. McDonough and his team as they update the 2015 roadmap and how they would situate this report so it adds value to that effort. Mr. Winokur said he did not envision Dr. McDonough's group presenting a series of recommendations to the SAB and receiving the feedback. They are specifically updating that strategy, incorporating elements that RMDL Gallaudet discussed, and looking forward in a ten-year time frame. They are not recommending that they do an update to that strategy because this is the update to the strategy. Dr. McDonough said they definitely want that type of advice from the SAB. The original document was more of a tactical document, and this update will better position NOAA for what they would like to do over the next ten years to further their use of these systems.

Lynn Scarlett commented that the huge advances in the potential of unmanned vehicles has significant R&D implications and is another crosscutting thematic area that should be addressed in the R&D Plan. Situational analysis will be critical for the plan, and these kinds of inputs are highly relevant to that situational analysis. Dr. Matlock said there are several aspects to the topic of unmanned systems that he expects will be incorporated into the plan.

Data Sciences and Decision Support Presentation

Robert Grossman, University of Chicago and SAB Member

Christopher Lenhardt, RENCi and SAB Member

Robert Grossman introduced the presentation on Topic 4, the proposed focus of which is Artificial Intelligence, Data Science, and its Applications to the NOAA Mission. The group is not concerned with the difference between AI, data science, machine learning, and deep learning, but will instead focus on a set of technologies and their application to the NOAA mission. These topics include a number of elements relevant to the various themes the SAB is considering, including model and data assimilation, big data applications, applications of data science and AI to problems of interest to NOAA, decision support, and fisheries stock assessments. The task group recently met with NOAA's Chief Data Officer, Ed Kearns, to gain high-level insights into AI activities at NOAA. NOAA has formed a working group on AI and is planning a workshop on AI and its applications. The team is collecting names of additional NOAA personnel to approach for informal information gathering. Based on initial discussions, the team decided to focus on four big topics:

- Selected applications of AI and data science to the NOAA mission.

- Enabling technology, including the required data management and cloud computing infrastructure.
- Issues around preparing NOAA data resources to be AI and data science “friendly.” For example, how to lower the cost and effort required for use with AI and data science applications and services.
- How AI and data science might accelerate NOAA’s economic impact and contribute to an increase in U.S. competitiveness.

Each of these topics will be considered from two perspectives, the R&D aspect and the operational systems perspective. Each of these contain four necessary lines of operation: generating the data, making the data AI-friendly, supporting enabling technology, and then providing the community application and other tools for R&D and deployment into operational systems. The team will remain in an information gathering phase for the next few months. The team’s recommendations for SAB consideration were:

- Task the DAARWG with preparing a brief report with analysis of key issues and potential recommendations related to the following:
 - Recommendations for preparing analysis-ready datasets.
 - Recommendation for training researchers to work in this area.
 - Recommendations for preparing training data for machine learning.
- Request a short report from the NOAA AI Working Group on the topic of AI, with a briefing at a future SAB meeting:
 - What NOAA missions would AI have the biggest impact on, both near term and intermediate term?
 - What are some efforts to capture and share knowledge related to AI across NOAA?
 - What is the technology readiness within NOAA to use AI and data science?

If these two recommendations are approved, the team would use them as inputs, continue discussions with the experts they have identified, and bring their findings together in a report to be presented at a future SAB meeting.

Christopher Lenhardt said the team has discussed the various AI-related threads to this topic, as well as the broader context of rapidly developing technology. He felt they were at an optimal point to try to help make sure these connections are made. It is better to address issues like capacity building and updating standards now than it would be after further progress is made. Other relevant topics that may arise include issues related to archiving and long-term management of software and code. Incorporating AI in this context would be an element of that topic. There are also concerns about ethical issues related to the use of AI and the sensitivity of algorithms to flaws in the data they rely on. This would be especially important for AI that is applied to decision making for situations like disaster response. The team is also discussing whether learning algorithms can be used against data to help extract meaning so that users have more ability to leverage the data.

Discussion

Everette Joseph asked for clarification on what the group meant by training researchers to work in this area and if there is a deeper question with respect to workforce needs and limitations. Dr.

Grossman said that he didn't think there would be enough space to say much about workforce issues in the report, and the topic is also covered elsewhere. This report will say just enough to be a placeholder for a more thorough discussion in the future. Mr. Lenhardt said he views the report as discussing how this technology gets integrated at all levels of the NOAA enterprise, but they will only be able to highlight a starting point. Dr. Joseph recommended simply stating that workforce is a critical issue because it could make the difference in how the technology is accelerated and applied at an enterprise level. Lynn Scarlett said the SAB may want to take up this issue as a focused topic area in a future Work Plan.

Martin Storksdieck said the team is addressing a lot of questions that the AI and data science fields in general are struggling with, but asked what in the report is specific to NOAA. He also asked who will read the report and what will they be expected to do with it. RDML Gallaudet said he would like to have the topic of workforce addressed in the report in some capacity. He views AI as the next IT in the evolution of scientists. Just as scientists have all had to learn to write code, AI proficiency will be the next step, and NOAA wants to create the right environment for helping the workforce advance and ensure that they have the necessary tools available. RDML Gallaudet is interested in what kind of strategic plan the agency needs to generate and how they should organize along those lines to realize the benefits of AI, while also ensuring minimal redundancy. He has been considering the possibility of creating an environment that is a repository of all NOAA's work, both private sector and in-house solutions, to serve as a reference for employees in order to minimize the amount of extra work being done. Dr. Storksdieck said there have been many funding opportunities to create the workforce of tomorrow made up of transdisciplinary scholars who are simultaneously trained in AI and other disciplines. There have been developments in training the future workforce that would bring a completely new set of people to NOAA; the question is whether they know that this opportunity is available. RDML Gallaudet said that NOAA employs many polymaths that are highly skilled in diverse disciplines and the agency needs to recruit more of these.

Mary Erickson said that while sometimes it is helpful to have a vision of the workforce for the future, it's really powerful to have an element of these issues addressed within a specific technical component. A workforce-wide view is so broad that it only touches the surface of many important areas.

Lynn Scarlett reviewed the task group's recommendations and asked Ed Kearns if number two, a report from the AI working group, could be accomplished. Dr. Kearns said the AI Working Group is not yet formalized but he will get an answer to the SAB soon. Until that time, RDML Gallaudet offered to be the point person for this item. The SAB approved of this approach.

Cynthia Decker noted that they are working to increase DAARWG's membership, which currently has only three members. The first recommendation would be a considerable undertaking for the group. Chair Scarlett added that they could bring people in from outside of the formal working group for advice and input.

Coastal and Marine Transportation and Support Infrastructure Presentation

Denise Reed, The University of New Orleans and SAB Member

Denise Reed discussed the developments on Work Plan Topic 8. Working with the Co-chair of NOAA's Hydrographic Services Review Panel (HSRP), they identified areas that the SAB may

wish to pursue. This is not, however, a domain that the current membership of the SAB has much experience with. The potential uses of multibeam backscatter data was one topic that the HSRP was interested in. Larry Mayer from the UNH-NOAA Joint Hydrographic Center provided a presentation on multibeam backscatter technical issues. This presentation was shared with the SAB and Dr. Reed will also provide a report from the Backscatter Working Group. Multibeam backscatter has revolutionized the ability to understand the seafloor and is consistent with the principle of "map once, use many times." Analysis of backscatter can provide information about the textural composition and the nature of the substrate. The techniques used to analyze the data are similar to those used to analyze satellite data, so how the information is processed may have applications across different approaches. This is clearly a rapidly evolving area with an ongoing rich international dialog. The other aspect of the Coastal and Marine Transportation topic that was considered for collaboration was how PORTS (Physical Oceanographic Real-Time System) could be linked to data streams and models, and data assimilation used to provide more detailed information, particularly in relation to currents and areas that are important for navigation. While it was not clear that any of this work would produce a recommendation for NOAA, the discussions have illuminated insights from different scientific fields that could be of broad interest and potential applications to the agency. Dr. Reed asked the panel to consider if they wanted to explore this topic when there is already another NOAA advisory committee focused on it.

Discussion

Lynn Scarlett said this topic may be more appropriate for open-ended presentations intended simply to stimulate thinking and knowledge sharing. Mr. Winokur agreed and felt that the SAB did not have the expertise to offer much to NOS or NOAA that they didn't already know. He thought it would be good to have someone speak to the broader applications of multibeam backscatter at a future SAB meeting.

Steve Thur said that the SAB is not the only forum NOAA receives advice from. NCCOS (National Centers for Coastal Ocean Science) does habitat mapping using backscatter data and will be convening an external panel to give advice. The Office of Coast Survey does similar things through the HSRP and other external panels. He suggested the SAB not duplicate efforts on what the agency can obtain from more specialized panels. Chair Scarlett said that sometimes exposure to a topic by people who aren't experts can bring about interconnections or value for other purposes. Dr. Thur asked, since the purpose of the SAB is to provide advice to NOAA, if awareness-raising presentations lead to recommendations.

Denise Reed said that the PORTS sensors provide an improved understanding of real-time dynamics of very complex estuarine systems and may serve multiple purposes. If the SAB was going to include one of these presentations on a future agenda, her preference would be a focus on that as opposed to backscatter. Chair Scarlett said this fits in well with the SAB's blue sky discussions and she suggested Dr. Reed think about what such a presentation might look like. Dr. Reed agreed to but said that the path forward might be a pivot away from Topic 8 since the subject has drifted from coastal and marine transportation. Chair Scarlett thought it would be fine to say they explored this topic and pivoted direction.

Dr. Reed will send the materials from the effort to Dr. Decker to distribute to the SAB members.

New Technologies for Fisheries Stock Assessments Presentation (ESMWG)

Michael Castellini, University of Alaska at Fairbanks and ESMWG Co-Chair

Michael Castellini presented on work relevant to Topic 9 and provided background on the topic. The 2018 Stock Assessment Improvement Plan states that in order to provide the best information possible and meet demands for increased quality and quantity of stock assessments, NOAA must continually improve stock assessments with new developments in science and technology. The SAB tasked the Topic 9 team to evaluate fisheries monitoring technologies to improve stock assessments, taking into consideration how to optimally balance electronic monitoring, eDNA, and other technologies as well as incorporate the results of the UxS and machine learning topics. This was the first ESMWG project through the new SAB Work Plan method. The team met with NMFS, liaisons, and NOAA field offices to refine topics and their timeline, as well as to decide on the process. Several other meetings followed and they will be meeting with four different specialized experts in May. They expect to present a draft outline and topics to the SAB in July and have a final draft of their report in the fall of 2019. There are several overarching concepts that the group intends to emphasize. One is that none of these technologies are ready to “plug and play,” contrary to the belief that there are devices that could instantly be applied. They also want to emphasize that the technologies they reviewed are not likely in the immediate future to reduce investment, effort, or fiscal impact. The group spent a lot of time discussing what methods can be used and organized them by their state of readiness. These will be (1) near term and ready to field verify (e.g., modern methods in fish otolith chemistry for aging), (2) medium term at field testing stages (e.g., remote observing systems for assessment of ocean conditions and population distribution), and (3) longer term development that are being discussed in exploratory studies and university research (e.g., eDNA, 'omics, and molecular methods for species identification, presence, distribution, and life history). Dr. Castellini noted that the working group has five nominees going through the approval process.

Discussion

Cisco Werner provided updates on some of the examples Dr. Castellini discussed. NOAA is increasing their otolith capability in nearly every science center, but there is still work to do in terms of how they take the data and use it in their stock assessments. NOAA will also be utilizing UxS for acoustic work and doing a side-by-side comparison with eDNA results in order to compare signals. These methods are developing rapidly and NOAA needs to archive data and do continuing analysis on it. Dr. Castellini said the team spent a lot of time on the point that dedicated research is needed and comparative techniques must be applied between trusted methods and these new concepts.

NOAA Education Efforts: Discussion of Future Collaboration between the SAB and NOAA

Martin Storksdieck, Oregon State University and SAB Member

Louisa Koch, Director, NOAA Office of Education

Martin Storksdieck discussed the SAB’s long-standing engagement with NOAA as part of the federal plan for STEM (Science, Technology, Engineering, Math) education. The SAB has not produced anything on this topic in over ten years, so Dr. Storksdieck reached out to Louisa Koch to discuss potential collaborations. Dr. Storksdieck framed the discussion in the broader light of

social sciences, educational learning sciences, and their potential role in NOAA's mission. There is a large professional class of researchers that study scientists, learning, teaching, and cognitive processes, as well as behavioral change and the institutional arrangements that facilitate it. Much of this is relevant to what NOAA does and how they position themselves in the field of education and learning. What NOAA science means for the world may depend on professional approaches towards understanding how best to go the last mile. Having data is great, but successfully transmitting relevant information is more important. The new five-year plan tasks mission agencies and other parts of the federal government to think hard about NOAA's role in educating the public in STEM fields.

Louisa Koch provided context on efforts underway in the education world. The federal STEM Strategic Plan was released by the White House in December and is driven by congressional requirement. Congress has been active in trying to bring the federal STEM education community together and have them work in more strategic and integrated ways. This plan has a strong role for mission science agencies. The Department of Labor and other non-science agencies are also deeply involved in the effort because the plan is not focused solely on science. The focus of the plan is primarily on the technology, engineering, and math aspects of STEM education. The plan attempts to bring in more state government, private sector, and nongovernmental stakeholders into the partnership. Three pathways the plan lays out are (1) develop and enrich strategic partnerships, (2) engage students where disciplines converge, and (3) build computational literacy. NOAA has identified actions to support the plan in these areas. NOAA is heavily involved in fostering STEM ecosystems, bringing a wide variety of capabilities into STEM learning for individuals. Ms. Koch presented some 2018 NOAA education metrics and the impact of the agency's work in people's lives. Institutions want to work with NOAA and people are interested in getting NOAA content into their resource materials. Through these partnerships, the agency is able to leverage their investments in science and make them more accessible.

Discussion

Martin Storksdieck said that the SAB will be receiving a NOAA report on how the agency perceives its role in education. He is particularly interested in helping scientists understand how to communicate, not only with non-peers but with peers and near-peers as well.

Transdisciplinary science presents challenges for the research report in rethinking how science is being done and what it requires. The question of the public's understanding of NOAA science is a very different topic. NOAA as an organization is heavily involved in scientific literacy and stewardship, but it is unclear what this means. How NOAA curates its information and how professional it is in positioning itself in the public discourse is something that requires consideration. He asked the SAB if they want to engage in addressing these issues and, if so, in what ways.

Louisa Koch said the SAB's input would be helpful on education's final mile and a focus on not just the quality of NOAA science but how well the agency is impacting the people that are interacting with the resources they manage. An assessment of Fisheries social science efforts could be informative for other parts of NOAA that are interested in better connecting to their audiences.

Lynn Scarlett commented on the distinction between the issue of attracting more students to the STEM fields and the topic of science communication, which raises questions about how people

learn, what they trust, and what forms of information are accessible to non-STEM people. There are many dimensions to this but it is still a one-way flow of information. There is a third area, which is critically important and under-examined, which is the interface between science and decision making and between science and behavioral motivation/change. This is not simply a matter of communication form and words, but of ongoing relationship-building. There is a growing recognition of the value of mutual learning, or co-learning, which could be valuable to the issue of final mile engagement. Dr. Storksdieck agreed that science engagement needs more two-way understanding. The 2008 SAB report on this topic took many of these ideas into consideration, including a recommendation that NOAA change its mission statement. He recommended building on that report, updating it, and bringing it into the current conversation. He asked if the SAB believed it had the expertise needed to fully address this topic.

Louisa Koch said they have been reviewing the SAB's recommendations on citizen science, as well as a National Academies presentation on the topic. They found that the results of citizen science are much more valuable when the citizens are more broadly engaged with. In NOAA, the citizen science community has been supported and connected on the education side and they would like to see more of that support on the research side.

Mary Erickson said the Weather Service has made the shift towards "impact-based decision supports." When engaging with decision makers, it is critical to convey how the science impacts the decision they need to make. This requires the scientist to understand the perspective of the decision makers. These relationships are essential to working with emergency managers during hazardous weather. This has been a major shift and NWS is beginning to see the fruits of the effort, but there is still much more to learn.

Lynn Scarlett said this area was what she envisioned for Topic 5, but it was shelved. She suggested that she and Richard Moss meet with Dr. Storksdieck and Ms. Koch to see if there is a way to reconfigure Topic 5 around this topic. Dr. Storksdieck agreed to join the Topic 5 team. The SAB agreed to this approach.

Plans for Next Meeting

Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett said the next meetings will be a webinar in June followed by a July in-person meeting in Seattle, Washington. At the June meeting, the SAB will review the SAB recommendations on the NOAA R&D Plan, and approve NOAA's input on the strategic aquaculture science plan. These are both decisional items that are time-sensitive. For the July meeting, the SAB anticipates decisional items from EISWG and ESMWG, as well as a review of draft products. Dr. Decker presented a list of other possible agenda items for the Board's consideration.

Discussion

Denise Reed said that the SAB's usual procedure when setting up meetings outside of Washington, D.C., is to receive presentations on NOAA science underway in the area. She proposed getting regional information directly relevant to the work the SAB is focused on rather than broad overviews. Private sector AI developments and stock assessments at PMEL (Pacific

Marine Environmental Laboratory) may be good choices. Chair Scarlett said there was general agreement with this approach.

Everette Joseph suggested reaching out to PMEL leadership to clarify with them what the SAB is looking for.

Martin Storksdieck requested fewer PowerPoint presentations and more conversation with presenters. The slide deck should be available before the meeting to facilitate discussion.

Bob Grossman said a topic for consideration should be getting information from NOAA about cloud computing changes and some of the other changes that might impact either the access model or the pay model for researchers and others. Chair Scarlett said that the question has repeatedly come up: if you're relying on the private sector and that relationship ends, what happens to the data and data interactions that had been created under the prior relationship? Dr. Decker said that the data session was more focused on the presence of Amazon and Microsoft in the region and getting updates on topics like NOAA's Big Data Project.

Lynn Scarlett suggested they get input from NOAA, then think creatively about mode of presentation/engagement, about diversity of subject matter, the timeliness of the issues in terms of reports that are coming due, and about what regional activities may be most relevant to the SAB's Work Plan, then create a draft agenda and disseminate it to SAB members for comment. Dr. Decker also asked the SAB to consider if they are interested in a field trip. Dr. Thur asked if the members would be interested in touring PMEL, NOAA's largest facility, which may feed into a future Work Plan topic on whether NOAA has the right physical infrastructure to accomplish the science the SAB is recommending. Dr. Decker said they had explored the possibility of holding the meeting at PMEL, but the logistics did not work out.

Review of Actions

Cynthia J. Decker, Executive Director, SAB and Designated Federal Official

Dr. Decker reviewed the actions from the meeting, including:

- SAB Office will work with Lynn Scarlett and Martin Storksdieck synthesize the discussion regarding the SAB input to the NOAA Strategic Research and Development Plan Outline. The SAB will review and transmit to NOAA.
- The SAB accepted the report from the Environmental Information Services Working Group on Observing System Simulation Experiments with a small modification from Eugenia Kalnay (working with author Xubin Zeng). The SAB will transmit the report to NOAA subsequent to the revision.
- NOAA will respond to the SAB report on OSSEs no later than one year.
- The SAB agrees with the recommendations made by SAB members Robert Grossman and Chris Lenhardt on the approach to the SAB Work Plan Topic 4 Data Science, AI, and Machine Learning and expects them to move forward in their work with NOAA and the SAB Data Archive and Access Requirements Working Group.
- SAB Member Denise Reed will provide the SAB with presentations/ materials collected in support of SAB Work Plan topic 8 Marine Transportation.
- SAB Member Denise Reed will draft some language of a way forward with a pivot on Work Plan Topic 8 and circulate for SAB input.

- SAB members Lynn Scarlett and Martin Storksdieck will work with others to develop an aspects of SAB Work Plan Topic 5 that addresses communication between scientists and stakeholders.

The next SAB meeting will be June 18, 2019 via webinar.

Adjourn

The meeting was adjourned at 12:25 p.m.