

67th Meeting of the NOAA Science Advisory Board
April 14-15, 2020

Location: Webinar

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:

Mr. John Kreider, President, Kreider Consulting LLC (Chair); Dr. Mike Donahue, Vice President and Director, Water Resources and Environmental Services, AECOM; Dr. Robert Grossman, Frederick H. Rawson Professor and Jim and Karen Frank Director, Center for Data Intensive Science, University of Chicago; Everette Joseph, Director, National Center for Atmospheric Research (NCAR) ; Dr. Ruth Perry, Marine Scientist and Regulatory Policy Specialist, Shell Exploration and Production Company; 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, STEM Research Center and Professor, College of Education and School of Public Policy, Oregon State University; Dr. Elizabeth Weatherhead, Senior Scientist and Fellow, Jupiter Intelligence; 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 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 and performing the duties of NOAA Chief Scientist; Dr. Steven Thur, Director, National Centers for Coastal Ocean Science, National Ocean Service; Dr. Louis Uccellini, Assistant Administrator for Weather Services and Director, National Weather Service; Mr. Harry Cikanek, Director, Center for Satellite Applications and Research, NESDIS; Dr. Cisco Werner, Director of Scientific Programs and Chief Science Advisor, National Marine Fisheries Service; Dr. Gary Matlock, Deputy Assistant Administrator for Science, Oceanic and Atmospheric Research; Dr. Steve Volz, Assistant Administrator for Satellite and Information Services; Ms. Mary Erickson, Deputy Director, National Weather Service; Dr. Eric Kihn, Director, Center for Coasts, Oceans and Geophysics, National Centers for Environmental Information; and Dr. Kenric Osgood, Chief, Office of Science and Technology, National Marine Fisheries Service

Staff for the Science Advisory Board in attendance:

Dr. Cynthia Decker, Executive Director and Designated Federal Officer; Ms. Courtney Edwards; and Ms. Caren Madsen

April 14, 2020

Opening Statement of the Chair

John Kreider, Kreider Consulting and Chair, NOAA SAB

John Kreider welcomed the attendees to the meeting and called the roll. RDML Tim Gallaudet provided introductory remarks, including congratulating Mr. Kreider for being selected as Chair of the SAB. With the ongoing COVID-19 pandemic and the election in November, NOAA has a short period in which to complete the work they set themselves to in 2017. Neil Jacobs said NOAA is both time-constrained and resource-constrained with many initiatives and priorities they want to see through which they believe will put the agency in a better place. He noted that because the EPIC (Earth Prediction Innovation Center) request for proposal was currently out, the agency was not able to say much about it.

SAB Consent Calendar

John Kreider, Kreider Consulting and Chair, NOAA SAB

- December 2019 SAB Meeting Minutes
- Working Group Status Reports

Martin Storksdieck made a motion to accept the December 2019 SAB meeting minutes; Elizabeth Weatherhead seconded the motion and it passed unanimously. Mike Donahue made a motion to accept the working group status reports; Bob Grossman seconded the motion and it passed unanimously.

Presentation of NOAA Priorities

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

Summary

RDML Gallaudet discussed progress made on NOAA's overarching priorities. Given the election in November, NOAA leadership requested that the SAB identify work the agency can complete in the near-term. In order to focus on these quick wins, NOAA endorsed the SAB dispensing with their two-year work plan approach. NOAA's key priorities are implementing elements of the Weather Act and enhancing the blue economy through its five pillars: (1) Navigation Services for the Marine Transportation System; (2) Ocean exploration; (3) Seafood competitiveness and aquaculture; (4) Tourism and recreation, supported by the National Estuarine Research Reserve System; and (5) Coastal resilience, supported by coastal zone management. One example of the progress on these priorities is the Presidential Memorandum on ocean mapping, which gives NOAA direction to develop a national strategy, an Alaska strategy, and recommendations on improving the permitting efficiency for ocean exploration work. These priorities are underpinned by the science and technology strategies NOAA has developed for artificial intelligence, unmanned systems, 'omics, and cloud computing. Strategies for data strategy and citizen science are currently being developed. NOAA encouraged the SAB to consider how best to integrate the strategies cooperatively as well as enable the agency's overarching priorities. 5G is an issue NOAA needs to address and the agency is preparing a response to Congress on its impacts to their mission. The partnership aspect of all this work is something NOAA is eager to see move forward. The administration is keenly interested in the Pacific Islands and the Indo-Pacific and building NOAA's capacity for hazard prediction and response, particularly in regards to tsunamis, is very important. NOAA is also interested in working with interagency partners to explore opportunities for global environmental science brought about by decreases in human activity during the COVID-19 crisis.

Discussion

Bob Grossman asked how the agency is thinking about aligning the AI, cloud, and data strategies or if there is a committee reviewing the Implementation Plans as they move forward. RDML Gallaudet said each of the strategies has a cross-Line Office team assisting with their development. There is also a larger cross-Line Office committee that is addressing the integration of these documents, which is comprised of all of the strategy team leads and meets monthly.

Bob Winokur asked for more information on the priority concerning Sanctuaries, specifically what NOAA's notion may be for the SAB's role. RDML Gallaudet said Sanctuaries are a key priority for the agency. NOAA is in the process of expanding the Flower Garden Banks and Monitor National Marine Sanctuaries, as well as drafting two proposed designations in the Great Lakes. The issue of noise is important because of the agency's interest in permitting for shipping, maritime commerce, and Naval activities in a way that mitigates the impact of noise on marine mammals and wildlife in these pristine ecosystems. There has been a tendency to lean towards regulations in order to limit transmissions and noise levels, but NOAA and the administration want to limit regulation by using best science and technology (S&T) available, such as dynamically managing shipping and noise levels using real time sensing technology. Mr. Winokur asked if the SAB will get a briefing on what NOAA has been doing with regards to noise. RDML Gallaudet said that is up to the SAB but he would be happy to facilitate it and he would like the board's input on the current strategy.

Craig McLean provided a brief update on the International Quiet Ocean Experiment. The National Science and Technology Council (NSTC) convened a group to examine ocean noise, which is greatly reduced due to the decrease in human activity as a result of the pandemic. Some specific questions they were asking included to what extent can the reduction in sound be measured and whether additional deployments are needed during this quieter period. Their consensus was that reasonably sufficient monitoring is in place to make a measurement of the reduction in sound from the normal, but they need to make a commensurate measurement with how much maritime activity was reduced, which will have to come from other agencies/organizations with additional surveillance techniques. Mr. McLean has reached out to some of these groups to see what information they may have available. Mr. Winokur asked if there are hydrophones in the Sanctuaries now to compare before and after and added that it is not just those measurements that are needed, but also the ocean conditions of the transmissions. Steve Thur said the underwater noise investigations in the Sanctuaries are varied; some are for specific endangered or threatened species, while others are looking at ocean noise as a possible real time monitor for potentially illegal activity, and others are using sound to measure biodiversity.

John Kreider asked Dr. Volz for further elaboration on his request to DAARWG for advice on NOAA's transition to the cloud. Dr. Volz said the context of the request was that the alignment of the strategies has been happening at the Executive level, but the execution is happening at many different levels and in many places simultaneously. He thought there might be value in having the SAB consider the topic from a slightly different perspective. NOAA is very sensitive in how they work with the cloud service providers and getting their input can be complicated due to contractual relations. One of NOAA's suggestions to the SAB would be to step back from

those complexities and assess how NOAA should be considering their approach to utilizing the cloud service providers in general and using cloud-native capabilities more effectively. Chelle Gentemann said NASA is also struggling with many of these issues on how to deploy cloud-optimized data in a way that is most beneficial to AI. DAARWG may need to delve further into the different Line Offices to understand the challenges that each of them will be facing in trying to bring data to the cloud. This is an area where DAARWG would be excited to contribute. Molly Jahn added that DAARWG is looking to add new membership so an overview of the Line Offices' challenges, needs, and priorities would be useful in helping with their selection. Dr. Volz said one of their objectives is to move into the cloud parallel with and connected to NASA so they have common systems with common access in order to maximize the benefits of AI. Dr. Jahn requested a specific contact in order to make a lateral link and Dr. Volz suggested Kevin Murphy, who runs the data archives for NASA's Earth Science Division. Dr. Gentemann said it will also be important that, whichever provider is chosen, they be as cloud-agnostic as possible.

Louis Uccellini said he is reviewing the Data Dissemination Plan and commented that a lot of work has been done on archived data sets. There is a significant difference from a timeliness and reliability perspective in accessing data from an archive and delivering data. NOAA has responsibility for delivering data and large data sets but the emphasis in most discussions has been on accessing the data for various purposes. He urged people to consider those differences when pursuing this discussion and not presume that it is automatically the same cloud technology or architectural design for accessing archive data than delivering real time data. Chair Kreider said he recognized the issue of two different types of demands, but felt that it is a great opportunity to see what kind of progress can be made.

Neil Jacobs said the agency has been looking at the cloud issue extensively and some of the motivation behind trying to focus on cloud vendor agnostic solutions is largely a business model rather than a technical solution. This approach allows for easier porting between service providers and also protects against vendor lock. NOAA has been in conversations with cloud service providers on rapid access versus access to historical data and they have the ability to do either. Users will pay a premium for fast access, while more cost-effective solutions will be available for more flexible users. Security needs also need to be taken into consideration and any external advice the SAB could provide would be extremely helpful.

Bob Grossman said that, in this context of large scale use of the data, especially for machine learning and aligning with the artificial intelligence (AI) strategy, the DAARWG may want to consider an agnostic framework that would include real time architecture, data archive architecture, and an integrated architecture for all the operational or active data that is not necessarily in archive but is being actively used in various projects.

John Kreider asked for elaboration on the partnerships priority and what the SAB can do that would be of the most value to the agency. RDML Gallaudet said NOAA has many excellent examples of partnerships on the wet side, but requested that the SAB help to identify what they think would be the most productive partnerships worth pursuing elsewhere. Dr. Jacobs said NOAA needs to be careful about tracking software engineering, code development, and management as it pertains to the potential job market and what is coming out of the universities. The agency should take steps to avoid getting boxed in from a software engineering perspective

and on software and code that is obsolete or so unique that adequate expertise is not readily available. Ensuring they have good collaborative relationships with private industry is the best way to position the agency to be sure they are on a common trajectory and to avoid isolating themselves from future expertise. He also noted that there are a lot of private industries aggregating data and observations completely unrelated to NOAA's missions but that may be something the agency can extract value from.

Everette Joseph asked for NOAA's perspective on specific areas of alignment with The White House Office of Science and Technology Policy (OSTP) guidance on earth system predictability and how the SAB can assist in this area. Dr. Jacobs fully agrees with the push for coupled systems and he is looking at technical solutions to enable this, specifically by aggregating and centralizing the code and the observations both for initialization and verification. Bundling similar or synergistic projects in order to reduce redundancy could also be extremely helpful. He asked for SAB input on identifying ways to build out earth system modeling, and thought starting with the Unified Forecast System and Global Modeling Program made the most sense. There may need to be some prioritization on what other models NOAA looks at from a coupled perspective and where to focus the research. If the SAB could identify concerns and priorities and link those back to predictability issues, it would be very beneficial. RDML Gallaudet added that the SAB's assistance with choosing what approach to use and when would be helpful. Dr. Uccellini said they are really in a theoretical area as much as an applications area, which is fertile for basic research to provide a better understanding of earth system science. The frameworks in which the code resides will be really important and the community needs to consider this. The other aspect of this is that NOAA is entering an era of multi-model ensembles and the extraction of what is the most likely forecast is enhanced by AI. This is also upending assumptions about what is predictable and for what timeframe. He would like the research community's advice on what the optimal mix of models would be (i.e., how many models are needed, what kind of coupling is needed to realize the full predictive capability, etc.).

Elizabeth Weatherhead asked if there is someone at NOAA who is the point of contact for private and academic partnerships to ensure there is some coordination at the higher levels about developments in AI and machine learning or if implementers find boots on the ground level relationships more useful. RDML Gallaudet said there are people at every level connected well and ready to engage in new partnerships.

Elizabeth Weatherhead asked how the pandemic situation is affecting work related to the priorities. Climate data will be particularly interesting for analysis later on and she asked whether the international carbon flask measurements are going forward. Mr. McLean said they are less than 5% down on the global flask collection currently and do not believe that reduction is a significant impediment to their mission. Staff members in Boulder are still conducting the analysis and NOAA is doing its best to sustain the effort. The difficulty has been at certain sites where the collections are made that have their own domestic limitations on people's movements. Observatories continue to be staffed and monitored. There are other impacts across NOAA's mission, such as the GO-SHIP (Global Ocean Ship-based Hydrographic Investigations Program) project, which had to be truncated. Dr. Volz added that NESDIS and OAR have been looking very carefully at global observing system observation requirements to investigate the impacts of COVID, both with the reduction in human activity and the eventual resumption of activity, in

order to tease out second or third order environmental signals. They will be bringing a proposal to the Research Council to look at how to do this in a coordinated way across NOAA.

Craig McLean said there is always pressure on the policy team that comes with an elected president to demonstrate results within four years. The products NOAA is relying on in order to stand on those wins, in many cases started long before. The SAB might have an opportunity to be looking for risk-taking, early readiness level research, which NOAA's budget is not currently well formulated to support. The SAB's insights toward advancing NOAA's state of expertise in this area would be helpful. NOAA also needs to be exploring exoscale computing and what will need to be put in place when it arrives. The agency needs support in doing these things because as they move budget items forward there are other items that take a more urgent priority. He encouraged the SAB to be thinking of where the longer-term health of NOAA's science programs lies beyond the horizon of the immediate return. Steve Thur added that he believes NOAA has a fear of discussing failure and this hinders the agency. If the agency is only focusing on the R&D activities most likely to produce success, they are leaving many potential gains on the table. He requested the SAB's input on the appropriate level of riskiness of portfolios and how they might be appropriately scaled. Chair Kreider agreed about the agency's unwillingness to talk about failure and said that the only way to do continuous improvement is to talk about successes and failures and derive lessons learned. Not many organizations do this well and it is an area where the SAB may be able to provide advice.

Martin Storksdieck was pleased to see citizen science included in the priority list and asked how the agency is thinking about the use of citizen science. RDML Gallaudet said the America Competes Act calls for citizen science specifically, which would complement Dr. Jacobs' vision for developing a community-based modeling effort. NOAA has been doing an extraordinary amount of high potential citizen science work, though little of it is coordinated or supported institutionally. He would like to use the strategy to create an environment that features cross-Line Office collaboration so that the high return on investment (ROI) approaches can be more easily identified and supported institutionally. Community-based modeling provides a good model for this and the prize competition component seems promising. NOAA is still drafting the strategy for citizen science and looks forward to the SAB's input. Rob Johnston noted that the Ecosystem Sciences Management Working Group (ESMWG) created a short report on citizen science that has been submitted to NOAA. RDML Gallaudet said they leaned heavily on this report and it is referenced in the draft strategy.

NOAA Artificial Intelligence Strategic Plan and AI Center

William Michaels, NOAA NMFS; Co-Chair, NOAA Artificial Intelligence Committee

AI has provided the agency with many benefits including data quality control, automated data processing, data assimilations, model parameterization, and predictive forecasting. The purpose of the agency's AI Strategy is to dramatically expand the application of AI in NOAA's mission areas in order to achieve transformational improvements in performance, skill, computational efficiency, and cost effectiveness. The strategy consists of five goals: (1) Establish efficient organizational structures and processes to advance AI across NOAA; (2) Advance AI research and innovation in support of NOAA's mission; (3) Accelerate the transition of AI research to applications; (4) Strengthen and expand AI partnerships; and (5) Promote AI proficiency in the

workforce. Mr. Michaels discussed each of these goals and their related objectives and highlighted some of the messages from the recent NOAA AI Strategy Implementation Workshop. An AI data call within NOAA identified about 100 AI applications underway agency-wide. NESDIS and NWS AI projects are mostly focused on data assimilation and forecasting applications, while NMFS has an emphasis on using AI to accelerate processing. Key drivers in NOAA's application of AI-ML (artificial intelligence and machine learning) include the need to improve data assimilation and forecast modeling, as well as the need to accelerate the data processing of big data collected from emerging technologies. NOAA has applied AI-ML to a variety of environmental data demonstrating its interdisciplinary research and operational capabilities in support of its cross-functional mission requirements. These include satellite and meteorology, underwater imagery, aerial imagery, electronic monitoring, active and passive acoustics, and environmental observations. The goal of NOAA's recent AI Strategy Implementation Workshop was to develop the framework for the NOAA AI Strategy Implementation Plan to make transformative improvements in the "One NOAA" cross-functional mission priorities, including how the AI Strategy can support or be supported by the other NOAA strategies. The 36 invited participants provided well-balanced perspectives and expertise from each NOAA Strategy Team and Line Office. The workshop report is currently in draft form. Next steps include: completing and disseminating the workshop report, including recommendations on coordinating synergistic operation efficiencies across the NOAA strategies; completing the data call analysis; completing the business case for a NOAA Center for AI and recommendations on oversight for the NOAA AI Strategy Implementation Plan; completing the NOAA AI Strategy Implementation Plan, including defining activities, milestones, and oversight, in FY2020; and completing budget requests for the NOAA AI Strategy Implementation Plan.

Discussion

Bob Grossman said that slight changes in data can lead to very different outputs, making them open to different kinds of attacks. He asked if there is a strand in the Implementation Plan that is looking at these kinds of challenges. Mr. Michaels said this is an extremely important question. The top priority is the integrity of NOAA's science. NOAA needs better awareness of best practices, as well as better coordination on the foundation of AI, which is high quality data and well-labeled training sets. Coordinating these would be one of the goals for the proposed NOAA AI Center, along with the necessary oversight for prioritizing and ensuring best quality. Dr. Grossman said that even some deep learning techniques for very large training sets have a lack of robustness or stability, and this should be kept in mind.

Joellen Russell asked what key mission-critical wins are included in the plan and, specifically, what improved outcomes and metrics are associated with the plan that will make the investment worthwhile. RDML Gallaudet said the strategy is laid out at a high level and the follow on implementation plan will identify more specifics on what metrics NOAA will use to assess moving forward in order to track progress. The strategy identifies things like improving forecast skill, performance, and efficiency. Broadly, the strategy directs that this be applied to every mission area. Mr. Michaels added that the strategy includes AI examples that have provided benefits, including improvements to forecast models to reducing data processing time. What the agency really needs to be thinking about is cultural. AI is closely tied with the agency's

computing requirements. As the agency builds AI partnerships and makes their information more open to a wider community, they are adding value to the NOAA data enterprise, which will be a big benefit down the road.

Elizabeth Weatherhead said one of her institution's biggest challenges is not necessarily getting the AI right and implementing it, but explaining the value to the end users and ensuring that they are interpreting the information correctly. She asked if the agency has a strategy for educating not just colleagues in NOAA but also the public on interpreting the results and making the most of them. Mr. Michaels said that is one of the reasons they are interested in a NOAA Center for AI. Workforce proficiency discussions included training requirements for higher level training and for the wider community.

NOAA 'Omics and eDNA Strategic Plan

Kelly Goodwin, NOAA OAR; Chair, NOAA 'Omics Strategy Committee

The vision for NOAA's 'Omics Strategy is to integrate modern 'omics technologies across the agency, transforming its approach to biological investigation and accelerating sustainable management of ecosystem resources for the benefit of people, communities, and economies. DNA sequencing has transformed the way biology is done, revealing unanticipated complexity, diversity, and relationships. The new techniques are sensitive and fast and can help improve NOAA's delivery of products and services. NOAA is developing and applying 'omics methods to address a variety of its priorities, such as combating harmful algae, enhancing fisheries and aquaculture, and improving the efficiency of their sample processing, and generally supporting the blue economy. The five goals of the strategy are: (1) Enhance infrastructure to meet the analytical demands of 'omics data; (2) Execute 'omics research targeted to support and advance the U.S. blue economy; (3) Accelerate transition of 'omics research into operations; (4) Expand partnerships to advance 'omics research and applications across the agency; and (5) Promote workforce proficiency in 'omics. Dr. Goodwin discussed the strategy goals and their related objectives, along with examples of work currently underway. A 2018 survey of NOAA staff revealed that gaps in infrastructure/computing power, staffing, and bioinformatics expertise impede implementation of 'omics. These survey results informed the goals and objectives in the strategy. An internal draft of the strategy should be available in the coming months.

Discussion

Ruth Perry asked who will replace Ed Kearns as Chief Data Officer on the project. Dr. Goodwin said they will be discussing at an upcoming meeting whether he will be replaced or not. If not, David Layton may be filling some of these roles on the team. RDML Gallaudet said NOAA leadership is not especially keen on designating a new Chief Data Officer for the team, given the other efforts underway involving cloud and data strategies. It will likely be a mix of people filling those functionalities.

Adrienne Simonson noted that the Chief Data Officer role is currently being filled by Zach Goldstein and she is happy to fill in where she can along with others.

Bob Rheault noted that the strategy lists several infrastructure desires and asked how realistic they are and if there will be financial support for that list. Dr. Goodwin said that one of the ideas for strategy and implementation plans is that they can form the eventual ask of what these programs need in order to implement the vision. They worked carefully to include a variety of actions that can be done with no new resources and are just dependent on getting people together and collaborating. RDML Gallaudet said this is all scalable and NOAA will work with what they have. He was able to push forward an 'omics element in the recent stimulus submission to the Department of Commerce.

John Kreider asked what the SAB or any of the working groups might do to help. Dr. Goodwin thanked the SAB and the working groups for their help already. The SAB could assist further by helping to make connections to new partnerships, particularly those that have undertaken similar projects elsewhere. 'Omics is a rapidly evolving field and no one person can keep up with it all, so having many eyes on it is helpful. Advice on where the agency should be technologically, partnership-wise, new uses for the data, and lessons to be learned would also be helpful. Chair Kreider asked if any organizations or countries come to mind that are in the lead on this topic. Dr. Goodwin said the EU has been very forward-thinking on this in a number of areas. Tara Oceans is an organization that has put a lot of work towards the most difficult part of 'omics, which is long-term time series. One thing they hope the strategy will help achieve is for NOAA to become a leader internationally in the use of these types of technology and data for marine systems and the Great Lakes. Craig McLean added that the National Ocean Partnership Program (NOPP) is an able convener for an interagency outlook on 'omics and there is interest at several other agencies that NOPP is bringing into alignment.

John Kreider asked how the effort to engage the National Science Foundation (NSF) has developed. Dr. Goodwin said the Interagency Working Group on Biological Data Sharing is a very active group that includes all of the major players, including NSF, National Center for Biotechnology Information, Department of Energy, and others. At the highest level this is coming out of OSTP, which is where the cross-agency discussions are currently happening. There is a NOPP RFP out in which all the strategies are being supported and research projects on the strategies are potentially supported. Mr. McLean said there was previously an 'omics proposal inside of NOPP and he expects it to come back around. There are various components of it that also deal with a diverse biological observing network which uses 'omics as diagnostic test. NOAA will have some opportunities for how they do stock assessments and the 'omics tools could be an accelerator to that. Because a lot of this activity is in a highly regulatory environment, it is essential to bring these along with the surety to be able to withstand challenges once they arrive. On the purely scientific side, there is no better tool under development to watch ecosystems migrate to whatever changes they will experience and have reporting as it happens, rather than relying on forecasts.

Kelly Goodwin asked the board how they envisioned themselves helping this effort. Chair Kreider said his sense is that this is a rapidly evolving area with huge potential in its early stages of being applied. There are a lot of people doing work, but perhaps not a clear center of excellence looking at it broadly. In that sense, he didn't think the SAB could add a whole lot in the way of connections to partnerships. He would love to see continued connections with technology demonstrations. Combining 'omics techniques with UxS could be a game changer,

though he did not have a good sense of how far in the future that will be realized. Dr. Goodwin said they were in the middle of organizing an Alliance for Coastal Technologies workshop with a focus on trying to bring potential commercial partners that could work on the front end of sampling. Autonomous underwater vehicles take about an hour to filter a sample. Speeding this first step up would revolutionize the whole capability. Slow filtration is a problem for manned ships as well. Chair Kreider said that the SAB could help facilitate a meeting of people with specific knowledge of 'omics, including potential end users and key technologists from different fields that might bring solutions. Dr. Goodwin said that would be great, but one of the issues NOAA has is that they're not a big enough player with the kind of money that pharmaceutical industry can bring to the issue. There are several stakeholders working on the same sort of questions, it's just a matter of making the right connections and getting the right people interested in NOAA's problem.

Public Comment

There was no public comment.

April 15, 2020

Welcome

John Kreider, Kreider Consulting and Chair, NOAA SAB

John Kreider welcomed everyone to the second day of the meeting and reviewed the day's agenda.

NOAA Tsunami Program

Michael Angove, Director, NOAA Tsunami Program, NWS

John Murphy, Chief Operating Officer, NWS, introduced Michael Angove. Mr. Angove presented an overview of NOAA's role in tsunami observations, predictions, and warnings, as well as some of the S&T initiatives they are pursuing domestically and internationally to improve their capability. The U.S. Tsunami Warning System is composed of many parts end-to-end that involve nearly every Line Office. The Tsunami Program's capability is driven by the NOAA Warning Centers and these are underpinned by a large observation dataset, including data from the U.S. Geological Survey's Global Seismic Network and National Earthquake Information Center, the Deep-ocean Assessment and Reporting of Tsunamis (DART) Network, and coastal observations from NOS' National Water Level Observation Network (NWLON). Additional dependencies include National Centers for Environmental Research (NCEI), National Data Buoy Center (NDBC), and the Caribbean Tsunami Warning Program. They are highly dependent on the states and Congress to ensure that appropriate resources are in place. The Tsunami Program also has a large international responsibility under the Intergovernmental Oceanographic Commission (IOC). The U.S. provides most of the forecast advisory services for the Pacific and Caribbean. This is a different mission than the domestic mission in that this is advice, not warnings, but smaller islands are dependent on the Pacific Tsunami Warning Center (PTWC) to provide these capabilities. Mr. Angove discussed the program's efforts in moving from an alert-based capability to a forecast-based capability. They need to know very soon after origin what has happened in order to prescribe the right response. NOAA currently does not have this capability, but rather one based on detecting large earthquakes and then establishing a sort of

proxy relationship. This is fine, but it does not provide information about the tsunami itself. NWS has developed the DART network, but there are only 39 stations worldwide and they do not provide bottom pressure everywhere it is needed to really get into the target zone. The Tsunami Program has made progress towards this and Mr. Angove commended Craig McLean for preparing the space within the UN to make these ideas attractive to pursue, in terms of S&T initiatives that relate directly to societal outcomes. Particular initiatives that could advance the program's effectiveness include GNSS-derived displacement vectors, which are observations that report the magnitude of an earthquake and the deformation of the earth as the ground stations move. This data can then be directly inverted and forward-modeled in order to get a deterministic forecast output. This approach has challenges, such as not having enough density in key areas like the Aleutian Islands. A potentially more attractive option for filling some of these gaps is leveraging deep ocean cable networks owned by large companies for moving high-speed internet data. This would be the perfect backbone for affixing instrumentation because it has the throughput and power needed in order to instantaneously pull the pressure data out of the bottom of the ocean and make it available globally. Dr. Angove hopes that the UN Decade of Ocean Science will provide the opportunity for a dialogue between high levels of industry, philanthropic organizations, and governments on whether this is a practical method.

Discussion

John Kreider asked what the impediments are to moving forward with the deep sea cables idea. Mr. Angove said there are a number of challenges. Better instruments are needed and work is underway to develop these. The bigger challenge is engaging industry because their risk tolerance is zero for putting instruments on their cables. A strategy is needed to work out how the process would work, but they are looking to access new deployments rather than retrofitting existing cables.

Brad Colman asked for discussion on the Tsunami Program's R&D initiatives' alignment with the priorities in the Weather Act, how their program's reports are coming, and if there is anything the (Environmental Information Services Working Group) EISWG could do to assist. Mr. Angove said that getting an advisory board established was a good step. In 2010, the Ocean Studies Board wrote a great summary of the Tsunami Program and its challenges that is still highly relevant.

Craig McLean said Mr. Angove has made him aware of demonstration projects of cables being installed in parts of the world that have different funding mechanisms behind them and NOAA may want to consider a new approach, looking at the different principals behind the projects. He also said that within the UN Decade of Ocean Science community, the value proposition of having a more expanded global warning system has been embraced. Given the number of nations behind this effort, there should be enough energy to expand the network using the technologies that Mr. Angove described. Mr. Angove said that the JTF SMART (Joint Task Force on Scientific Monitoring and Reliable Telecommunications) initiative, which is looking at areas to demonstrate this idea of putting cable-mounted tsunameters at the bottom of the ocean, is moving forward.

Martin Storksdieck asked what is known about the degree of risk that different populations have in various parts of the coasts and what is known about the people that have to respond to the warnings related to their particular coastline situation and the abilities of their infrastructure. Mr.

Angove said state partnerships are essential in this effort and that is what the National Tsunami Hazard Mitigation Program is designed to address. It is made up of 28 partner states and territories that work together and with NOAA, USGS, and FEMA (Federal Emergency Management Agency) in order to do exactly this. He discussed a FEMA exercise in the Cascade area that looked at not just how to get people evacuated, but if people were evacuable. Based on their findings, the State of Washington has taken additional measures such as installing a tsunami-engineered vertical evacuation structure in an elementary school gymnasium roof.

Elizabeth Weatherhead said that this is another product that NOAA produces that benefits the world internationally and asked if NOAA is getting the appropriate credit for its contribution. Mr. Angove said at the IOC level there is an understanding that their program would not exist without U.S. contributions. No one else can bring the capability to the table to make the system work. Mr. McLean agreed and said that the closer people are to the issue, the better understood this is but outside of this group, people don't realize how much the U.S. and NOAA are contributing.

RDML Gallaudet said that he loves the idea of dynamical prediction of tsunamis and believes that it is obviously where NWS needs to go. He requested that the SAB provide ideas on how NOAA can better work with philanthropic organizations, similar to the agreements they now have for ocean exploration. These are people that would get behind this mission if they were educated on its potential and he is happy to be a champion for it. He noted that the Weather Act includes a tsunami component and they should be thinking about ways to leverage that in order to advance the agency's capability. Mr. Angove said the Weather Act paints a great capability picture, it's just a matter of what items receive the resources needed to move forward.

SAB Tsunami Science and Technology Advisory Panel (TSTAP)

John Kreider, Kreider Consulting and Chair, NOAA SAB

The TSTAP was authorized in the Weather Act and will serve as a panel under an existing SAB working group. The purpose of the TSTAP is to provide advice to the NOAA Administrator on matters regarding tsunami science, technology, and regional preparedness. The draft terms of reference include: (1) At least every four years, review administration activities related to tsunami research, detection, forecasting, warning, mitigation, resiliency, and preparation; (2) Advise the NOAA Administrator and make recommendations for improvement; (3) Address other tsunami matters as requested; (4) Will be a panel of 6-8 members under the existing EISWG, with SAB liaison and will work with other federal agencies conducting tsunami work; (5) The panel members will include both academic and practical expertise and involve tsunami science, coastal engineering, emergency and disaster management, social scientists, and public education. TSTAP will deliver a report to the NOAA Administrator through EISWG every four years beginning in 2021. If the SAB approves these terms of reference, the Nominations Committee will be formed in May with members approved by the end of June. The first meeting, which may be virtual, will be in late summer of 2020 and a draft report will be delivered to the SAB at their spring or summer meeting 2021. The final version will be sent to the SAB by Fall 2021 and a report to the NOAA administrator, who submits to Congress, by December 2021.

Discussion

Bob Winokur said that four years is a long time between reports and he would recommend at least annual updates to the SAB after the initial report in 2021. Chair Kreider said that the requirement is “no less than every four years” and agreed that at least annual feedback to the SAB would be good.

Bob Winokur also commented that the EISWG already has difficulty getting members that are not encumbered with responsibilities from their day jobs and looking for another 6-8 members may be overly aggressive. Dr. Decker said that the terms of reference include a statement that the group could become a standalone working group of the SAB if that seems to be appropriate, though she was still awaiting clarification from NOAA’s Congressional Affairs Officer on this. Another option is that the panel could stand down between reports. The tasking to the TSTAP is specifically the quadrennial report. Mr. Winokur said the second option seemed very disruptive and continuity would be preferable. Dr. Colman said it may be best to figure out the domain expertise they want represented on the TSTAP, see what expertise the EISWG currently has, and then augment as needed.

Denise Reed said trying to make it too perfect too quickly will cause them to lose the timeline they have established. She also suggested clarifying the charter to explicitly outline the process for providing advice to the NOAA Administrator through the SAB. Dr. Decker added that it goes through the EISWG as well. Chair Kreider said they would make this modification.

Martin Storksdieck said one could think of this as a cumulative report, with annual reports being more dynamic responses to what one hears and then the burden is not so high for the four-year report. This would engage volunteers more than an episodic approach.

Mary Erickson said NWS thinks the TSTAP connection with EISWG is a good one, given their Weather Act responsibilities. If more continuity with the SAB is needed, a PowerPoint presentation each year would be fine. They are attempting to balance the engagement with the burden for team members. She thought bringing on EISWG members with experience in this area to form a core group and provide continuity, then augmenting with specific expertise as needed was a good suggestion.

John Kreider called for a motion to approve the TSTAP terms of reference. Cynthia Decker read the modifications that would be made, including clarifying that the report to the Administrator would be through the EISWG and SAB and that there could be an annual report to the SAB between four-year reports.

Elizabeth Weatherhead made a motion to accept the draft terms of reference with the modifications discussed; Bob Winokur seconded the motion and it passed unanimously.

Discussion on NOAA Priorities and the SAB Work Plan

John Kreider led the discussion. NOAA’s activities on the focus areas and the Implementation Plans provide a great opportunity for the SAB to collaborate on critical cross-cutting topics. There are a wide variety of topics from which the SAB can choose. NOAA priorities to be integrated by the SAB into work going forward include cloud, AI, coastal resilience, how NOAA can leverage innovations in private sector and federal partners, other climate observations that should be considered, and advising NOAA on activities, partnerships, and technology development. Other potential items for the SAB include gaining knowledge on and discussing a

number of topics, reviewing and commenting on the draft revised Science Integrity Policy when available, advising on the strategy to mitigate 5G interference with weather satellite water vapor sensors, and TSTAP. Chair Kreider reviewed the current working group taskings and potential themes from the last two SAB meetings, including: creating a more structured pathway to innovation; how the SAB can incorporate NOS needs; how to weave social sciences into emerging technologies; emphasizing partnerships and innovation; characterizing a rapidly changing marine environment and understand what the new ocean looks like; and issues of coastal resilience, such as rapid changes, changing mix of use, and multi-stressor prediction. From discussions with Assistant Administrators and working group chairs on how the SAB could be more valuable to them going forward, Chair Kreider gleaned the following responses: (1) NOAA deals with complex systems which change rapidly and require interdisciplinary approaches, so what are strategies to improve collaborations and how should the agency adapt to the rapid pace of change (versus the long process of peer review and publishing); (2) Advise on strategies to improve effectiveness of partnerships; (3) Identify common best practices and lessons learned for interactions among SAB, working groups, and NOAA; and (4) How to take advantage of SAB and working group expertise to “look around the corner” and advise on next big changes in science and technology that will move the agency forward in its ability to carry out its mission. The SAB’s goal for its Work Plan is to be responsive to NOAA leadership’s request for urgency in 2020 while maintaining a focus on critical long-term issues. Chair Kreider recommended creating two lists of potential tasks for the board: one for topics for the 2020 response, identifying specific tasks, identifying the responsible individuals, teams, and NOAA points of contact for each task; the other for critical long-term topics, identifying potential topics from an integrated list and forming task groups to evaluate and report back at the next SAB meeting. He suggested forming a subgroup to delve into the specifics of the longer-term topics that will report back to the SAB at their next meeting. He presented a list of topics for consideration and discussion.

Denise Reed commented that one thing that is missing is what the SAB has already done on the topics in recent years. There were several items listed that have been the subject of substantial SAB discussion. She also endorsed coastal resilience as a topic the SAB should take up. This is her field and as a volunteer board, the SAB should address topics that take advantage of the expertise of the members. The SAB should also consider the value of continually taking up the same issues. Chair Kreider said there was no way to include all of the work SAB has done in the past on the topics, rather the list is meant to look forward to what to take on next. Dr. Weatherhead supported taking up coastal resilience, in part because NOAA plays such a key role in providing fundamental observations as well as products, and also because the private sector and academia are heavily involved. Dr. Reed felt coastal resilience was a very broad area and should be considered a long-term topic, though the SAB may be able to identify a particular subset of the issue that could be addressed in 2020. RDML Gallaudet suggested a near-term win on this could be engaging with the NSTC’s subcommittee on disaster resilience, which is currently working to produce something on the issue. This would be a good opportunity for the SAB to either support their work or review or provide feedback on it. He would be happy to make that connection.

Rob Johnston provided an update on ESMWG’s report on decision making under deep uncertainty. The report has been delayed due to the COVID-19 pandemic but they are still planning to make rapid progress on the report. Given that they are not likely to have an in-person

meeting with experts until the Fall, having something done in 2020 would be very tight, but they will be quite far along on the report by then and can provide interim reports.

Stephen Volz commented on the transition to cloud topic. DAARWG is already working on a review of the cloud approach that NOAA is taking. Rather than asking for a specific deliverable from them and then the SAB this year, NOAA would offer to provide a detailed briefing of the progress that has been made to the DAARWG and then let them decide what to do from there. Dr. Gentemann liked this idea and said that the DAARWG is currently scheduling a meeting for end of April/early May and they will coordinate this with NOAA. Mr. McLean said that the SAB has already enlightened NOAA on cloud strategy opportunities and he felt that the cloud issue now is a matter of procurement decision and organizational culture transition. If the discussion went into exoscale computing and other challenges, there may be some visionary merit in the SAB's time investment.

Molly Jahn said the consensus on DAARWG is that it works best when it is given specific tasks from the SAB. Dr. Gentemann agreed, adding that in the past DAARWG has struggled to really take advantage of the time and expertise of the members of the group. Having specific goals makes the members feel valued and helps maintain their investment in the group.

Dr. Grossman said that the DAARWG's report on cloud strategies was drafted in a very specific context. The transition has several issues going on simultaneously within the broader topic and it may be worth the SAB's time to disentangle them. Chair Kreider said that, being a clear NOAA priority with a strategic and implementation plan under development, it seemed like a good topic for the SAB's attention. He would like to have NESDIS and DAARWG develop the scope of the topic for discussion, as well as a timeline and expectations for feedback.

Bob Winokur suggested having DAARWG and some portion of the SAB do a full review of the AI and Cloud Implementation Plans that are under development and provide feedback to NOAA. Chair Kreider mentioned that Charly Alexander reached out to the Ocean Exploration Advisory Board asking them to form a small informal working group that would work with their implementation team focused on UxS. He thought it would be appropriate for Mr. Winokur or others to join that effort. Interfacing with the implementation teams for AI, citizen science, or 'omics is a good opportunity for the SAB to provide input.

Molly Jahn said one thing DAARWG intended to do, since it has so many new members, is to connect with each of the Line Offices. The implementations might be a good topic to bring up with them to see how it's going and get an informal reaction that might be useful to capture. She also noted that other agencies, such as NASA, are managing many of these same issues.

RDML Gallaudet said near-term action for the SAB could simply be reviewing and advising on the 'Omics and Citizen Science Implementation Plans. Dr. Decker said that the SAB has been very involved on citizen science already and produced a report on citizen science. The SAB would be valuable in commenting on the Implementation Plan because they are coming from a place of knowledge through the ESMWG. RDML Gallaudet said the plan references the SAB's work. Rob Johnston said the ESMWG would discuss taking up the topic, but some of the people who led the citizen science report are no longer on the working group. He asked what the SAB wants to see above and beyond the previous report. Chair Kreider said it would be interfacing with the team developing the plans and commenting on the Strategy and Implementation Plan.

Dr. Storksdieck offered to serve as SAB liaison for this work. Mike Castellini said that, in terms of the natural science and biology that ESMWG covers, it would make sense for them to do it. He asked for direction on how to act in light of the fact that ESMWG's latest report on 'omics was transmitted but NOAA had not yet provided a response. Chair Kreider said interfacing with the Implementation Team is what is being asked of them. Rob Johnston said ESMWG has focused on the ecosystem component of 'omics and is not set up to handle the genetics aspects. If the work is going to focus on genetics and lab science, other SAB and working group members might be better suited to take up the topic. Chair Kreider clarified that they can reach out to other working groups or the SAB to get expertise as required.

Elizabeth Weatherhead suggested that the partnerships issue, particularly with respect to climate issues and partnering with federal agencies as well as the private sector, is something the SAB could do well with. There is a big gaping hole here and the SAB could at least start the conversation in a productive direction. Dr. Perry echoed this and added that the opportunity is not just in the climate area but in building on the approaches that NOAA has taken with ocean exploration and emulating that model in other areas where leveraging partnerships could really advance innovation. Drs. Weatherhead and Perry were identified to lead the 2020 response effort on partnerships.

Everette Joseph said a number of topics could fall under earth systems predictability and asked Drs. Colman and Russell to comment on 2020 opportunities in this area. Joellen Russell said short term possibilities for earth system predictions include the COVID-related worldwide process study discussed later in the meeting, though this will likely take through the end of the year. Long-term possibilities would include looking ahead to where the synergies and highest ROI will be both from leveraging technology and training opportunities and the focus on a unified framework for modeling. Dr. Colman added that EISWG has been keeping in touch with the EPIC offices and they intend to update their previous report sometime in 2020. Dr. Uccellini said NWS has been looking to work with EISWG principally in trying to capture issues with prediction and predictability and suggested the SAB consider this. With earth system science, NOAA is looking for linkages across Line Offices and opportunities and advancements are starting to emerge, such as harmful algal bloom forecasting. Despite advances in predictability, connections to decision makers are still needed in order to actually make use of those predictions. Physical and social science need to be working together in ways they haven't before. Dr. Joseph wanted to encourage an offline discussion between EISWG and the Climate Working Group (CWG) on prioritization and articulation of the issue in a holistic way.

Ruth Perry said advancing innovation should fall under partnerships as a subtopic and maybe other categories as well. She also said there are things that they haven't addressed that could be folded up into other topics. Chair Kreider said that on the long-term side there may be additional topics and the opportunity to combine topics. He suggested forming a smaller group to look at the list and add/combine topics, then come back to the SAB with the recommended topics to move forward on. Members interested in joining this group should contact Dr. Decker or Chair Kreider. RDML Gallaudet said he liked what the SAB put together and it will help NOAA immensely. He thanked everyone for their responsiveness and demonstrating their commitment to the agency during this challenging time.

Climate Working Group Letter: Opportunity for COVID19-Related Earth System Monitoring and Prediction Efforts

Joellen Russell, University of Arizona and Chair, SAB CWG

Joellen Russell presented a letter the CWG drafted for the SAB's consideration, which identified the urgency to secure measurements of the profound changes that have occurred in the atmosphere and ocean during this time of reduced human activity due to COVID-19. The CWG requests that the SAB recommend immediate actions by NOAA related to COVID19-related earth systems monitoring and prediction efforts. There have been precipitous drops in aerosol and carbon emissions as industries and transport networks shut down in response to the pandemic. The decline in aerosols, nitrus oxide, and carbon dioxide emissions varies regionally. This moment presents unique opportunities to assess NOAA and academia's predictive capabilities and to provide data on health-pollution relationships. The CWG acknowledged NOAA's efforts to maintain their service to the nation under these challenging circumstances and recognized that capitalizing on these opportunities may not be possible. Given NOAA's tradition of ingenuity and resilience, the CWG was hopeful that the agency could capture some of these environmental measurements. The request includes three categories: (1) Assessing what NOAA can do; (2) Assessing what NOAA can organize; and (3) Assessing how NOAA can help. Acknowledging the importance of individual safety and health, and the emerging challenges to maintaining current observing systems, the CWG recommended that NOAA should determine whether it is possible to direct internal personnel to this opportunity and the potentially critical objectives. The key objectives of the effort include: (1) Observe, aggregate, and quantify aerosols, radiatively active gases, and their radiative effects, occurring in response to the pandemic-related decrease in transportation and manufacturing; (2) Bring together key modeling centers to explore and compare the impacts in their systems; and (3) Collaborate with public health agencies to assess NOAA's environmental prediction capability.

Discussion

Bob Grossman suggested modifying the title to be more accurate, as in "The impact of COVID-19 shelter in place practices on the environment," so that when people see it they don't expect it to be about the collection of COVID-19 data. Dr. Weatherhead pointed out that the letter discusses environmental factors that affect vector-borne disease. Dr. Russell said that there are already papers out suggesting certain particulates of short-lived trace gases have a significant impact on the severity of symptoms of COVID-19. Pollution has dropped in some places and not others, which presents an opportunity to look at this.

Elizabeth Weatherhead noted that the letter points to the private sector's activity in this area and asked if the CWG sees a unique role for NOAA in this issue. She also asked if the CWG has considered the roles of different sectors or collaborations. Dr. Russell said they did and felt these other players' roles are important, but the foundational measurements are NOAA's purview.

Louis Uccellini said that other agencies are involved in making the actual prediction of the environment, and then the releases to the public are done at the state and local level. NOAA is in contact with the Department of Health and Human Services and the Centers for Disease Control and Prediction on a real time basis to ensure consistency in their messaging and to get guidelines from them. NOAA currently predicts the air quality aspect within their models in partnership with other research groups. With respect to health vectors, they are also actively working through the World Meteorological Organization and U.S. State Department on disease vectors, principally for Africa. This is all already happening and these three objectives could help build

on that work. He agreed that if NOAA does not get the observations listed in the letter, the research will definitely suffer downstream.

Gary Matlock said NOAA fully agrees with the recommendations in the letter and they are working very hard to protect the employees' and partners' safety, and still carry out as much of their day-to-day mission as they can while adding to it the kind of assessments and planning as they can. The Research Council met to discuss potential research that needs to be added in order to carry out the work that this crisis affords the opportunity to do. They are maximizing the funds they have available to carry on the routine, long-term observations that are the foundation that allow for examining the perturbation and its effects on what occurs now and in the future. Currently about 99% of NOAA's routine collection continues to be collected with additions where they have the capacity to do so. The biggest challenge they have is in ocean observations because of the impact to NOAA's fleet and aircraft. There will be more impacts the longer the pandemic goes on.

Craig McLean said NOAA started looking at this issue in early March. Through a combination of effort – NESDIS from satellite, OAR from in situ – the atmosphere observations are covered. NOAA is also currently looking at ocean sound and the degree to which ocean sound has been reduced by the decrease in human activity. One of the strengths NOAA has is its observing systems that have been resident for decades, which allow them to look at the impacts of world events in the record. The agency's weakness is that they don't have much fungible money to start up new projects. NOAA is not spending money at the same rate they normally would because of the halt in many of their field activities. They will be reprioritizing their spending in order to ensure an additional level of effort for the analysis after the event and any gaps they might see coming during the course of the pandemic.

John Kreider suggested making edits to the letter concerning the challenges NOAA has in meeting core mission requirements in addition to keeping people safe. He also thought it would be appropriate to add a statement recognizing and complimenting NOAA's ongoing efforts, including the fact that because NOAA has systems in place it allows capitalization on this opportunity.

Everette Joseph noted Mr. McLean's comments regarding NOAA's ability to move resources around in order to meet the challenges of securing these observations and asked if that should be addressed in the letter. Mr. McLean said they are reallocating when they can, but he ventured to say that NOAA does need resource assistance in order to do this well in terms of the long-term research and evaluation. The SAB will consider adding a comment on supporting the need for additional resources. Louis Uccellini emphasized that they are not moving resources around; they are working within the margins in areas where resources have been allocated to go above and beyond to ensure that these observations are in place. This is important as you get to the second and third objectives of the letter, because those will require new resources, not just internal to NOAA but also resources that get out to the research community.

Bob Winokur suggested changing "The SAB requests" to "The SAB endorses what NOAA is doing and recommends additional activities outlined in the letter." He did not feel it was appropriate for the SAB to make requests of NOAA when they are already strained. Chair Kreider agreed with this and wanted to include the importance of NOAA meeting its core mission requirements and the fact that they do not want to divert from that.

John Kreider said some edits to the letter are needed to reflect this discussion. He called for a motion to approve the letter with revisions, which will be circulated to the SAB and CWG for final approval. The SAB staff will work on the revisions with Chair Kreider and others as needed.

Bob Winokur made a motion to accept the letter; Martin Storksdieck seconded the motion and it passed unanimously.

Plans for Next Meeting

John Kreider, Kreider Consulting and Chair, NOAA SAB

John Kreider led the discussion. The dates set for the next meeting are July 22-23. If it is an in-person meeting, it will be held in Washington, D.C.; if not, it will be virtual following this meeting's format.

Review of Actions

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

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

- Approval of the consent calendar.
- Approval of the terms of reference for the TSTAP with some modifications. The SAB staff will work on making these modifications and then move forward with the process for establishing the panel under the EISWG, doing the best they can with the timetable that was established.
- SAB staff will finalize the NOAA priorities table developed by the board and send it to SAB members. They will also assemble a small group to develop the plan of action for the rest of the year. This group will be led by John Kreider and those interested in volunteering should contact Dr. Decker and Chair Kreider. This plan will be presented at the July meeting.
- Approval of the CWG's COVID-related research opportunities with a number of edits. The revised draft will be sent to board members and the CWG to inform them of the changes. Following this, SAB staff will draft a transmittal letter and forward this and the CWG letter to NOAA as advice from the SAB.

Adjourn

The meeting was adjourned at 4:18 p.m.