NOAA Science Advisory Board

2018-2019 Work Plan

Outline

Introduction

In 2016, the NOAA Science Advisory Board developed a Concept of Operations. As part of this document, the SAB and NOAA agreed a work plan should be developed every two years in conjunction with the renewal of the Charter. It should be based on the agency's mission and priorities and grounded in research and development plans put out at the agency, line office, and program level, as appropriate. This plan is the first such biennial work plan to be developed.

NOAA Mission

Science, Service and Stewardship

1. To understand and predict changes in climate, weather, oceans and coasts;
2. To share that knowledge and information with others; and
3. To conserve and manage coastal and marine ecosystems and resources.

NOAA Priorities

1. Lead the world in earth system observation and weather prediction;
2. Minimize impacts from severe weather; and
3. Increase the sustainable economic contributions of our fisheries and oceans

SAB Role

The SAB may serve different roles in providing advice to NOAA. It may serve as a "think tank" to give high-level thoughts on "blue sky" or "over the horizon" topics that are just emerging in science or society. It may delve into specific topics that cut across all or much of the agency and require in-depth consideration. It may react quickly to issues that come up on an *ad hoc* basis and due to unforeseen circumstances. Each of these situations will require different interactions with NOAA, different member structures and processes, and varying types of "products" to address them. This work plan will lay out plans to cover short-term topics of interest and a few that will take more in-depth analysis over the next 18 months. Issues that arise in the third (*ad hoc)* category will be addressed if and when they arise.

It is worthwhile to note that the SAB, in the past, has created working groups consisting of additional experts to address ongoing issues (standing WGs) and short-term questions raised by NOAA (*ad hoc* task forces). The SAB Work Plan is not intended to preclude such options but they should be used to enhance the ability of the SAB to provide NOAA with the best advice possible. An example of this is the work proposed to be done by the Environmental Information Services Working Group (EISWG) under Priority 1.

<u>Next Steps</u>

In order to develop a set of potential projects, the SAB will convene one or more subgroups to brainstorm ideas. These will be based on the NOAA priorities, topics raised by members, and ideas coming from SAB working groups. The subgroup(s) will formulate a set of potential projects for the SAB with appropriate timeframes, level and types of expertise needed, and a notional plan for addressing each one. These will be presented at the SAB meeting in April 2018 for discussion with the full SAB and NOAA leadership. Based on that discussion, the SAB will select projects and move forward on them.

Topics discussed with RDML Tim Gallaudet included ocean exploration, the water cycle, aquaculture, and decision support, but there could be others within the context of the NOAA priorities.

BY PRIORITY

<u>NOAA Priority 1: Earth System Observations and Weather Prediction</u>

Oversee development and implementation of EISWG Work Plan (list from WRFIA)

The Environmental Science and Information Working Group was established by the SAB in 2009 and then made permanent by provisions in the Weather Research and Forecasting Improvement Act of 2017 (Public Law 115-25), hereafter referred to as WRFIA. The WRFIA specifies certain activities where the EISWG is to advise and assist NOAA line offices in meeting the terms of the Act. These include to:

- prioritize of weather and climate research and development initiatives in NOAA
- advise on existing or emerging technologies from private sector & academia for better monitoring and analysis of weather and climate events and improved weather and climate forecasting
    - Earth system (ES) modeling. ES Prediction capability, coupling, data assimilation, computation. Elements of modeling. Current focus on the dynamic core, what should

the priorities be after that? What is next missing key element? For example, different physics implementations.
    - Observing component: how to apply new technologies for a more comprehensive and cost-effective local, regional, national, and global weather and climate monitoring system
- advise enhanced communication between NOAA weather forecasters and decision makers at national, state, and local levels, e.g., city and county emergency managers
- enable improved communication among NOAA, private sector, and academia

The EISWG has entered into discussions with the National Weather Service (NWS), Ocean and Atmospheric Research (OAR), and National Environmental Data and Information Service (NESDIS) to address these. It has been asked by NWS for advice on how to include the academic and commercial weather communities to address the challenges of improving weather and climate monitoring, analysis, and forecasting and the innovations needed for this. The EISWG is also ready to respond to OAR's call for advice on how better to position itself to prioritize its research and development efforts in this context. Because this is such a large and potentially daunting task, the EISWG has asked the line offices to provide it with their best options to which the WG can react in a timely and specific way.

In addition to the above, the EISWG is responsible for assisting NOAA (via reports and recommendations passed through the SAB) with review and updating of policies for interacting with the private sector (i.e., the partnership policy).

Review the use of Observing System Simulation Experiments (OSSEs)

An OSSE is a modeling experiment used to evaluate the impact of new observing systems on operational forecasts when actual observational data are not available. OSSEs are done: 1) to find out if a new observing system will add value to NWP analyses and forecasts; 2) to make design decisions for a new observing system; and 3) to investigate the behavior of data assimilation systems in an environment where the truth is known (Prive & Errico PPT, 2015). NOAA uses OSSEs in many of its programs for a number of purposes related to its observing and modeling activities. The SAB might consider learning more about these efforts and how/when they are used and make recommendations for improvements and/or suggest additional NOAA programs that may benefit from their use. This SAB could refer this topic to the EISWG as well; it would fit under their mandate from the WRFIA.

<u>NOAA Priority 2: Impacts from Severe Weather</u>

Assessment of NOAA Social Sciences projects (from Monica Grasso and NOAA SS Committee). Per the request at the SAB meeting in October 2017, the SAB will review these and provide comments. (Timeframe determined by completion of reports but likely 3-6 months after that).

- Cooperative Research and Development Agreements (CRADA) Economic Impact Study
- Economic Value of Marine Vessel Observations
- Economic Impact of Space Weather

Decision support

The SAB can recommend what science is needed in order to enhance, develop, and facilitate effective use of the basic products; create a robust process for working with academia, the commercial sectors, and others to develop what is needed; engage with decision support tool users and related stakeholders to identify needs, test products and iterate on tools and systems; and develop an evaluation protocol that is embedded as an ongoing process within the spiral creation of the products and tools. Specific projects could include machine learning and working with the Social Sciences Committee to evaluate their progress on the Mission and Strategic Vision. Enhancing the relevance and utility of decision support tools involves technical, scientific, and communications expertise, as well as understanding the processes and ways in which users frame problems, define needs and use information.

Decision Support and machine learning

NOAA is a science-based services agency. A large part of what NOAA delivers is Environmental Intelligence. NOAA aims to deliver information in a way that people can use it for decision-making. To do this, NOAA invests in data gathering and analysis ("environmental intelligence") about fisheries, ecosystems, climate, weather, and other oceanic and atmospheric information. Gathering better information and presenting it to decision-makers and the public in useful and understandable formats can improve public-sector management and private-sector decision-making and result in improved outcomes for the citizens of the U.S.

During its November 2016 meeting, the SAB had a discussion with Dr. John Kelly III, Senior Vice President, Cognitive Solutions & IBM Research, IBM Corporation. During the meeting, Dr. Kelly talked about the use of Watson, an artificial intelligence (AI) platform for decision making in the health sector.

Can AI or machine learning help NOAA when creating tools for decision makers in the fisheries, ecosystems, climate, weather, and other oceanic and atmospheric discipline areas? What kinds of research should NOAA do to be able to incorporate machine learning into its decision-support services and tools? What kinds of data, data sets, and technology are needed for NOAA to engage with machine learning tools? Recently, the Weather Company, an IBM business, and the National Center for Atmospheric Research (NCAR) formed a partnership to enhance Watson's weather and climate prediction capabilities. The SAB could learn more about this new endeavor and provide advice to NOAA on determining how to leverage the partnership and develop research goals related to AI machine learning and positive societal benefits.

Decision Support and Social Science Aspects

In July of 2015, the NOAA Social Science Committee released *Vision and Strategy: Supporting NOAA's Mission with Social Science*, a document that set the agency's social science vision and strategy for the next 3-5 years. The document provides opportunities to align office and program efforts with the goals, objectives, and strategies outlined within.

Some examples of NOAA social science programs aimed at presenting NOAA data and information tools in a usable format to both private and public partners include: Weather-Ready Nation Ambassadors Program; Impact-Based Decision Support Services (IDSS); SKYWARN Storm Spotter Program; Storm Surge Program; and the Climate Program Office Communication and Education Program (CommEd).

Given all of NOAA's Social Science programs, what criteria does NOAA use to evaluate these programs to make sure each program meets the Social Science Vision and Strategy goal to strength societal decision-making? Are any goals missing from the initial three goals set by NOAA? How can NOAA evaluate each goal? Are there areas of social science not addressed in the document? The SAB can review one of NOAA's Social Science programs to see how it meets the goals set forth by the Social Science Vision and Strategy document. The SAB can also provide comments for consideration on the next iteration of the *Vision and Strategy: Supporting NOAA's Mission with Social Science* document.

NOAA Priority 3: Sustainable Economic Contributions of Fisheries and Oceans

Aquaculture

Sustainable marine aquaculture to diminish the gap in imports of fish to the US is a priority for the Secretary of Commerce. While the Marine Fisheries Advisory Committee of NOAA has done several reports on this topic in the recent past, the science and technology aspects of this have not been explored in depth. Most of the MAFAC work has focused on topics related to management of fisheries and management of aquaculture, such as data and science-based decision making and the regulatory and business environment. In addition, recent concerns about issues of aquaculture in federal waters, such as the impact of harmful algal blooms, have not been addressed at all. The science and technology aspects of future aquaculture could be explored by the SAB in conjunction with the Marine Fisheries Advisory Committee and the National Sea Grant Advisory Board (the latter because of its recently funded marine aquaculture initiative). (Steve Gaines, Bren School)

Benefits of long-term and large-scale ecosystem restoration (from original short-term topics document by the SAB, June 2017)

NOAA is involved in protecting and restoring coastal and marine ecosystems. There are numerous questions about the effectiveness and value of large-scale restoration. What are the benefits to society of large-scale ecosystem restoration? How does one set large-scale ecosystem restoration goals? (What scale? What attributes?) Can these benefits be quantified, either in monetary or non-monetary terms? When ecosystems are restored, how does this change the provision of various ecosystem services of value to society? What is the state of our knowledge about the success of restoration efforts, both in the near term and in the longer term? How does one measure outcomes of large-scale restoration? Does ecosystem restoration make ecosystems more resilient? What kinds of information are most needed to better prepare for and adapt to changes in environmental conditions and potential disturbances, and how should NOAA use information in decision-making?

Smart technology for stock assessments and new models behind stock assessments (this has overlap with, but differs from, the item on aquaculture)

Robotics, 'omics (encompassing genomics, transcriptomics, and proteomics), advanced and miniaturized sensors, and informatics are becoming important technologies for mission agencies, especially NOAA, operating in the marine environment. These technologies have potential advantages to NOAA for providing more coverage in time and space with less human intervention, making more efficient use of large infrastructure assets, including ships and moorings, thus offering the potential for long-term cost savings. NOAA personnel are currently involved in the development, testing and evaluation of these systems, and much of the appropriate expertise resides within the agency to help broaden the use of these technologies within NOAA.

NOAA received advice on some of these topics from the SAB and another Federal Advisory Committee, the Marine Fisheries Advisory Committee (MAFAC):

- *August 2016: SAB Issue Paper on "Potential Impact on NOAA of Emerging Genetic Technologies".* This paper discussed that environmental applications for omics, gene editing, and gene drives are likely to have increasing relevance to that part of NOAA's mission "to conserve and manage coastal and marine ecosystems and resources.
- *November 2016: SAB Report on Emerging Technologies for NOAA Ocean Research, Operations and Management in an Ecosystem Context (Ecosystem Sciences and Management Working Group).* The report discussed NOAA's current and potential uses of 'Omics, metabarcoding and eDNA; Robotic Vehicles, Autonomy and Artificial Intelligence (RVAAI); and applications of *in situ* digital imaging of marine organisms.

- *December 2012: Marine Fisheries Advisory Committee: Vision 2020 (v2.0) Charting a Vision for Marine Fisheries.* In the science and technology section, the report stated that technology for observations (satellites, acoustic surveys, sea gliders, GIS mapping etc.) is integral to the NOAA Fisheries' science program.

The SAB may want to review and update these recommendations in light of technology advances and potential new applications relevant to NOAA, such as the interagency Microbiome project.

National Blue Economy

The National Blue Economy broadens an understanding of ocean and coastal economies to include more than extraction-focused considerations to a knowledge-based economy where the sea is providing data, information, and services to address societal challenges and inspire their solutions. It represents a marriage of economic, social, and ecological outcomes. Many opportunities for economic development arise with the oceans and Great Lakes.

The U.S. ocean and Great Lake economy focuses on six economic sectors including: living resources; marine construction; marine transportation; offshore mineral extraction; ship and boat building; and tourism and recreation. Currently, NOAA's Office for Coastal Management, using data from the Bureau of Labor Statistics and Bureau of Economic Analysis, annually values the ocean economy with the Economics: NOAA Ocean Watch (ENOW), an online tool used to streamline the task of obtaining and comparing economic data, both county and national, for the six sectors dependent on the ocean and Great Lakes. ENOW's annual time-series data are produced for 400 coastal counties, 30 coastal states, 8 regions, and the nation. The SAB could pick one or more of the six economic sectors and provide NOAA with advice on how to better monitor the impact of that sector on the national economy. For example, how can NOAA better support the current industries impacted by the blue economy, or what new indicators should NOAA monitor to help determine the impacts that oceans and Great Lakes resources and ecological systems have on the market economy of the United States?