54th Meeting of the NOAA Science Advisory Board
29-30 October, 2015

Location: Hamilton Ballroom
Hamilton Hotel
Washington, D.C.

Presentations for this meeting have been posted on the Science Advisory Board (SAB) website: http://www.sab.noaa.gov/Meetings/meetings.html

SAB members in attendance:
Ms. P. Lynn Scarlett, Managing Director for Public Policy, The Nature Conservancy (Chair); Dr. Susan Avery, President Emeritus, Woods Hole Oceanographic Institution; Dr. Michael Donahue, Vice President, Water Resources and Environmental Services, AECOM; Dr. Jeremy Jackson, Senior Scientist Emeritus, Smithsonian Institution; Dr. Jennifer A. Logan, Retired (Harvard University); Dr. Molly Maucauley, Vice-President for Research, Resources for the Future; Ms. Jean May- Brett, Retired (STEM Partnership Coordinator, Louisiana Department of Education); Mr. Robert S. Winokur, Retired (NOAA, Navy); and Dr. Dawn Wright, Chief Scientist, Environmental Systems Research Institute.

SAB Working Group Chairs in attendance:
Dr. Christopher Lenhardt, Chair, Data Archive and Access Requirements Working Group (DAARWG); Dr. Walter Dabberdt, Co-Chair, Environmental Information Services Working Group (EISWG); Dr. David Fluharty, Co-Chair, Ecosystem Sciences and Management Working Group (ESMWG); and Dr. Robert Dickey, Co-Chair, Gulf Coast Ecosystem Restoration Science Program Advisory Working Group (RSPAWG).

NOAA senior management and Line Office representatives in attendance:
Dr. Kathryn Sullivan, Under Secretary of Commerce for Oceans and Atmosphere; Dr. Rick Spinrad, NOAA Chief Scientist; VADM Manson Brown, Assistant Secretary for Environmental Observation and Prediction; Dr. Russell Callender, Acting Assistant Administrator, NOAA National Ocean Service; Mr. Craig McLean, Assistant Administrator, NOAA Office of Oceanic and Atmospheric Research; Mr. Kevin Cooley, NOAA National Weather Service; Dr. Richard Merrick, Chief Scientist, NOAA National Marine Fisheries Service; Dr. Mike Kalb, National Environmental Satellite and Data Information Service; and RADM David Score, Director, Office of Marine and Aircraft Operations

Staff for the Science Advisory Board in attendance: Dr. Elizabeth Turner, Acting Executive Director; Dr. Bridget Seegers; and Mary Anne Whitcomb.

Thursday 29, October

Opening Statement of the Chair and Self-Introductions by Science Advisory Board (SAB) Members
Lynn Scarlett, The Nature Conservancy and Chair, NOAA SAB

Lynn Scarlett welcomed everyone. The SAB continues to have a focus on the strategic look ahead that we have been providing for NOAA. While we made progress there is more work to do and we will have insight from experts on our changing world and its impacts on NOAA and how NOAA delivers its services.

Consent Calendar
Lynn Scarlett asked for any comments on the three items on the consent calendar: August 2015 SAB Meeting Minutes, membership roster for the Ecosystem Sciences and Management Working Group and the Working Group reports. There were no comments; Jean May-Brett made a motion to accept them and Jeremy Jackson seconded the motion. The motion passed unanimously.

NOAA Update
Kathryn Sullivan, Under Secretary of Commerce for Oceans and Atmosphere

Summary

Dr. Sullivan welcomed everyone to the 54th meeting of the NOAA Science Advisory Board (SAB). She recognized the 7 years of service of Jerry Schubel, not able to attend this meeting, on the SAB and thanked him for his service. Dr. Schubel was an active member and also was the SAB liaison to the Ocean Exploration Advisory Working Group and a member of the Research and Development Portfolio Review Task Force; and has been a strong voice for informal education and ocean exploration on the SAB.

At the next meeting, she hoped to be able to introduce four new SAB members who are currently going through the security process.

Dr. Sullivan reminded the Board of the four NOAA priorities: help communities become more resilient, invest in observational infrastructure, evolve the weather service and achieve organizational excellence and will provide her update in this framework. But first, Dr. Sullivan provided an important update on our relations with Cuba as it spans across multiple priorities:

Cuba Update

The U.S. re-established diplomatic relations with Cuba in July; NOAA has worked with the Department of State since 2014 to collaborate with Cuba on oceanic ecosystems, natural resources, weather and climate.
The Secretary of Commerce met with Cuban leaders in October on topics including NOAA priorities particularly nautical charting, protecting our shared waters including research and marine protected areas. NOAA is leading this effort with the National Park Service and the Department of State in the management of marine protected areas and a Memorandum of Understanding on this topic is being reviewed by Cuba to be signed in the near future. NOAA and Cuban scientists worked jointly on a research cruise to explore the spawning and larval ecology of Bluefin Tuna on the Nancy Foster Research Vessel. Looking forward with Cuba, NOAA will initiate 4 additional hurricane preparedness and fishery management projects related

to Cuba including overflights over Cuba to provide better tropical hurricane forecasts radar weather data and service exchanges, data exchanges on red grouper and on pink shrimp fisheries.

Dr. Sullivan then provided a progress report on each of the NOAA four strategic priorities.

Resilience

NOAA played a major role in the second annual Our Oceans conference in Chile including the President's announcement of two new National Marine Sanctuaries for possible designation: Wisconsin-875 square-mile area of Lake Michigan that contains a collection of 39 known shipwrecks; and Maryland-14 square-mile area of Mallows Bay in the tidal Potomac River that is home to bald eagles, herons and numerous species of fish.
The comment period closes January 15 and then NOAA will make final decision on designation.

Also during the Our Oceans conference in Chile, NOAA announced a new partnership between Chile and NOAA on a joint research effort to test two of the new Deep Assessment and Reporting of Tsunamis (DART)-4G systems on the seismically active Chilean Trench. These fourth generation DART tsunami buoys are capable of warning nearshore communities of a possible tsunami by measuring the tsunami and providing real-time measurement information to feed into warnings and watches shortly after the earthquake occurs. NOAA also announced progress on implementing the President's directive to combat Illegal, Unreported and Unregulated (IUU) fishing and seafood fraud. The National Ocean Council committee on IUSS Fishing and seafood fraud finalized the list of at-risk seafood species; species determined to be at risk will be the focus of a risk-based seafood traceability program.

NOAA also announced new efforts to use the Visible Infrared Imaging Radiometer Suite (VIIRS), a space-based sensor, to provide data, tools and technical assistance to target IUU fishing. VIRRS is capable of detecting lights, including from boats that use lights to attract fishery catch at night, to target potentially illegal activities for further inspection by other assets. In 2016, the detection system and alert services will be implemented in Indonesia, the Philippines and three other countries.

Deepwater Horizon Settlement

On October 5, 2015, the Department of Justice lodged a consent decree among the federal government, 5 Gulf States and BP to resolve claims and raised the settlement to $20.8B.
NOAA and other Deepwater Horizon Natural Resource Trustees released a 15-year environmental ecosystem restoration plan for the Gulf of Mexico. The draft plan proposes future project-specific restoration proposals to:

- Restore and conserve habitat
- Restore water quality
- Replenish and protect living coastal marine resources
- Provide and enhance human use recreational activities
- Provide for long term monitoring, adaptive management, and administrative oversight of restoration efforts

The plan is currently undergoing public comment and, once approved/ finalized, NOAA will work with Trustees to plan, approve, and implement restoration projects. Many of these projects will benefit from a new water initiative to accelerate progress on integrating water data, new water models, and user needs, including new models on water food energy nexus. We need to take an integrated look at the total water system and demands at these nexus points and assure that all agencies are coordinated in this work. In FY16 we plan to turn on the first provisional products from the new national water model, including a specific "zoom" function that will allow us to increase spatial resolution for targeted water risk events. NOAA's new Water Center in Tuscaloosa, Alabama, is a focal point in this effort.

Evolve the National Weather Service

NOAA is working to make the National Weather Service (NWS) more nimble and capable. NWS conducted an Operations and Workforce Analysis beginning in May of this year with a goal to better understand our ability to achieve a Weather-Ready Nation going forward, including what the delivery gaps are and what actions we might need to take in the future.

Phase 1: Completed in August; provided analysis of NWS's operations, workforce, and organization, and identification of gaps in meeting needs. Key findings include:

- NWS employees are among the most dedicated and motivated within the federal government, with 75% of NWS indicating they are enthusiastic about their jobs.
- Communications between NWS management and the workforce contain persistent challenges which NWS leadership recognizes and is committed to addressing.
- NWS staff are highly skilled in science and technology, but have inconsistent capabilities in management, communication, and other skills deemed important for IDSS.
- By in large, NWS customers, including EMs and the media, are highly satisfied with the services the NWS is able to provide.

Findings were shared with all NWS employees, NOAA leadership, member of Congress, NWS employee unions and the Office of Management and Budget.

Phase 2: Ongoing exploration of options on how to address gaps and recommend alternatives for organizational structure, operating model (including IDSS), workforce model, and communications and stakeholder engagement.

Phase 3: By the end of this year, we will investigate actions to be prioritized for testing and implementation after which the NWS will build out action plans and begin making changes that are approved.

Creating a weather ready nation means properly understanding the talents of our team members and NWS held a national meeting of science and training leads (first in over 20 years), titled "Leading Science & Research into Operations to Build a Weather-Ready Nation", and included collaborative scientific discussions and idea sharing among field-based scientists/regional and national teams. Goals of this meeting included building NOAA's capacity to leverage the talents of our teams on agency research to operations (R2O) priorities in a focused and direct manner over the long term.

Achieving a Weather-Ready Nation also means making sure our forecasters have the necessary technology available at their fingertips and to that end the NWS completed an upgrade of Advanced Weather Interactive Processing System (AWIPS) in September at 144 locations nationwide including NWS forecast offices and river forecast centers. All NWS forecasters are now working with a more robust operational system that enhances ability to make precise and accurate predictions and issue timely, reliable warnings and advisories. AWIPS2 benefits include: increased pace of introducing new capabilities into operations; improved system maintainability and stability; and user interaction improvements.

VORTEX-SE Project

NOAA is also progressing on research on tornadoes. NOAA's National Severe Storms Lab and academic partners are ramping up a new tornado research program, planned for March/April 2016, made possible by Congress's $5.2M appropriation in FY15. VORTEX-SE will build on previous VORTEX field experiments and will focus on:

- Meteorological processes
- The way NWS forecasters detect and warn for tornadoes
- The way end users receive and respond to that information.
- Focus on sociological factors that contribute to high mortality in the SE.
- Explore tornado formation/intensity in an area beyond the Great Plains (rugged terrain, inadequate shelter and building codes, high frequency at nighttime).

Observational Infrastructure

Observations are the essential underpinning of all of NOAA's work, and at the end of August, Dr. Sullivan attended the Global Leadership in the Arctic: Cooperation, Innovation, Engagement and Resilience (GLACIER) conference in Alaska with President Obama and Secretary of State Kerry. The conference brought together foreign ministers from the 8 Arctic States and Arctic Council Observers to help broaden awareness and heighten the urgency to address the critical issues facing the region.

Dr. Sullivan delivered remarks and emphasized the need for sustained, systematic observations and authoritative science that will give us the understanding of environmental conditions and trends to forecast future conditions for the Arctic. Her remarks mentioned recent additions to the NOAA Arctic observation network including:

- Two new U.S. Climate Reference Network (USCRN) Stations in the Denali National Park and at the Selawik National Wildlife Refuge to develop our long term understanding of the impacts of climate variability and change.
- 26 new automated acoustic-stage river gauges (iGages), developed by NOAA's Alaska and Pacific River Forecast Center, deployed over the next 3-4 years to produce data needed by the aviation and marine communities.

- A new National Water Level Observation System Station in Unalakleet, tasked with collecting data on water levels, ocean waves, and river discharge to support marine and sea ice forecasts in a region particularly vulnerable to extra-tropical storm surge.

President Obama made several announcements at the conference involving NOAA:

- Survey of transit route through Aleutians and Bering Strait (NOAA/U.S. Coast Guard)
- Use of satellite data for shoreline and near-shoreline coastal mapping (NOAA, U.S Geological Survey and the State of Alaska).
- New Arctic sea-ice thickness satellite product (NOAA).
- Establishment of Resilience AmeriCorps, a pilot program that will recruit, train, and embed AmeriCorps VISTA members in 10 communities throughout the United States (NOAA, the Department of Energy, the Environmental Protection Agency and the Corporation for National and Community Service will partner with The Rockefeller Foundation and Cities of Service)

NOAA is committed to sharpening our focus on providing the data that supports real, on-the-ground needs in the Arctic while engaging the Arctic residents in citizen-science and community-based observations.

Another accomplishment in observational infrastructure involves NASA's Global Hawk. For the first time, real-time data from NASA's Unmanned Aircraft System (UAS) Global Hawk were integrated into NOAA's operational hurricane forecast models (Tropical Storm Erika) as part of the NOAA Sensing Hazards with Operational Unmanned Technology (SHOUT).NWS successfully assimilated dropsonde data from the Global Hawk of temperature, pressure, moisture, wind speed and direction from the tropical storm into the operational model. The SHOUT program is one of our Sandy Supplemental research success stories and will help move the Global Hawk one step closer to being put into routine operational use as a meteorological observation tool.

To address the ever growing need for environmental information, NOAA is fostering a flexible enterprise that is responsive to evolving technologies and economically sustainable. NOAA acquires its space-based Earth observation data in a number of ways, including government procured and operated, through public and private partnerships, and from commercial providers. NOAA has drafted a Commercial Space Policy, and recently published it for public review and comment. The new policy aims to establish broad principles for the use of commercial space-based approaches to help NOAA: 1) sustain its observational requirements and 2) open a pathway for industry to join the space-based Earth observation process by exploring new, emerging modes of partnerships.

NOAA is currently reviewing and processing the comments collected during the public comment period and will be releasing the policy soon. Policy guidelines include: honoring partnerships, enhancing international collaboration, and supporting full, free, and open data. The policy will maintain the integrity of NWS forecasts and warnings and affirm that NOAA will meet mission requirements on time, within quality standards, and as cost effectively as possible through mix of government assets, commercial services, and domestic and international partnerships. The policy designates Office of Space Commercialization (OSC) as the NOAA entry point for commercial

sector engagement; establishes demonstration projects as a potential avenue to validate the viability of commercially provided environmental data into NWS systems; and recognizes the importance of continuing to provide data to downstream private weather enterprises, academia, and research communities.

Big Data Update

At the August 2015 meeting, Dr. Sullivan provided an update on NOAA's Cooperative Research and Development Agreement (CRADA) on big data and is providing an update on that effort. Amazon recently announced that it had made our Next Generation Weather Radar, or NEXRAD, Level II archive (since 1991) available online to all, which includes data from 160 Doppler radar sites, transmitted every 5 minutes.

Possible applications for using this data range from longitudinal studies such as the migratory patterns of birds based on weather as well as possible commercial uses such as improving weather forecasts by private companies.

Organizational Excellence

NOAA is engaged in a number of programs to position the agency for success beyond this Administration. This year, our September Senior Executive Service (SES) Summit focused on the topic of workforce diversity and inclusion in our workplace. With the support and experience of VADM Manson Brown, Dr. Sullivan plans to make this one of her central priorities moving forward: to promote a culture, second to none, that recruits from every segment of society for all roles and positions and that provides opportunity for all to achieve their maximum potential.

A second focus is on process, through the development of guidance memos. In an effort to strengthen the strategic role of the Chief Scientist and NOAA's Assistant Secretaries, we are creating specific guidance to help all Line Offices with the budget process. This guidance, the Strategic Research Guidance Memorandum (SRGM), was given to NOAA employees at the end of August to be used to guide the FY 18 budget process. Guidance has also been provided by Holly Bamford on the oceans, coasts and Great Lakes portfolio and by Manson Brown for the NOAA Observing Systems Council.

A number of exciting meetings are on the horizon:

- Group on Earth Observations Plenary and Ministerial Summit, Mexico City (November) will focus on strengthening geospatial collaboration for sustainable growth and increasing demand for geospatial data requirements.
- Dr. Sullivan will address the Latin America Geospatial Forum, Mexico City (November) and discuss the value of earth observation systems and its impact on sustainable growth through Public-Private Partnership.
- Dr. Sullivan will meet with the European Center for Medium-Range Weather Forecasts (to discuss ECMWF operations and programs operation); UK Met office (to strengthen our cooperation on climate services to improve resiliency) and the National Oceanography Centre (to increase collaboration on ocean observations, ship-time sharing, and autonomous technologies).

NOAA will participate in the Paris Climate Conference (December) to discuss data sharing, oceans and adaptation and participate in events to address climate change domestically and around the globe. Also on global climate, Dr. Ko Barrett has been nominated to be Vice Chair of the Intergovernmental Panel on Climate Change (IPCC).

Discussion

Dawn Wright asked about the Water Center and asked if Dr. Sullivan could comment on the data project. Dr. Sullivan said the NEXRAD data in the Cloud will open new possibilities for the Water Center. The Water Center is located on the University of Alabama campus, which will be a benefit as we get more of an integrated agenda with partners and community. Jeremy Jackson asked about discussions with Cuba on coral reefs. Dr. Sullivan said that research is the key element in all discussions and suggested that he have further discussions with Holly Bamford on this topic.

Michael Donahue asked about the identification of the remaining Centers of Excellence to be designated under the RESTORE Act. Dr. Sullivan said she will find out the status of this information.

Molly Macauley said the SAB has worked to integrate and elevate social science: Can she assume it is a key part of what is happening in NOAA? Dr. Sullivan said social science is much more included in NOAA programs than it was s a year ago; funding, talent and capability are still issues. VORTEX 2 included social sciences at the beginning of planning and is now more front and center, but NOAA programs still need to connect to people. We will continue to ensure that research agendas recognize the need and work on science worth solving.

NOAA Chief Scientist Update
Richard Spinrad, NOAA Chief Scientist

Summary

Dr. Spinrad and the Office of the Chief Scientist have been focused on strategic internal activities. They have developed a critical piece of NOAA's research portfolio logic with the Strategic Research Guidance Memorandum (SRGM) issued on 24 August 2015. NOAA has never before had strategic research guidance to complement the Annual Guidance Memorandum. The SRGM has 2 components: a Framework of Principles (with the number one Principle being mission alignment) and set of Research Priorities that will evolve on an annual basis to guide strategic investment and divestment decisions in NOAA's R&D portfolio. The current SRGM has six research priorities. The SAB feedback was important in calling out process studies to balance the focus on modeling. Also, decision science, risk analysis, and risk communication reflect NOAA's movement towards including social science. The year to come will include efforts to apply SRGM to FY18 budget development. The portfolio will be examined with SRGM as guide.

Another effort has focused on the transition of research to application, operations, commercialization and other uses (R2X) by focusing on effective process. Readiness Levels

(RLs) have been developed for NOAA projects, which are useful for program managers and end-users to communicate throughout the transition process. NOAA is developing a process that includes an internal effort to find projects in the late development and demonstration stages and to prioritize those projects that could be accelerated to meet NOAA's mission needs, should resources become available.

NOAA is reevaluating the relationships and design of cooperative institutes (CIs) with an effort called CI21. The CI21 plan has been developed with CI directors and the CI committee within NOAA and will provide a list of detailed recommendations. The impact of the recommendations will carry on into the future. It will increase the CIs' abilities to address the needs of the agency and clarify expectations for partners.

Unified modeling will be a focus of the Office of the Chief Scientist for the next year. The goal is improved model interoperability, unifying physics, ecology, biogeography and human factors models across hydrosphere, atmosphere, and cryosphere. The effort will focus on scaling continuity in time and space and will support the R2X effort by creating products and tools. This will be done by enhancing and magnifying existing modeling efforts across line offices and by improving understanding of common modeling topics across the agency. There will be NOAA-wide roadmaps for achieving selected goals. Examples include biogeography *x* changing climate, full carbon cycle *x* earth system modeling, and warnings *x* decision science.

NOAA is focusing on the emerging opportunities that are associated with the new blue economy. NOAA is exploring what will be possible with data available through NOAA's Big Data effort. NOAA's data and new blue economy will support an open data innovation platform. The new blue economy is global and the nature of the new blue economy is service-based, information-dependent, and prediction-critical.

Discussion

Dr. Spinrad was asked about how efforts are being institutionalized in NOAA to help ensure the work moves through administration changes. He responded that bureaucratic efforts such as formal NOAA Administrative Orders (NAOs) are being combined with cultural changes by working with NOAA career leadership and demonstrating the utility of documents like SRGM.

Questions focused on how R2X projects are being evaluated and the how the end-users are being involved with the R2X transitions within and external to NOAA. Dr. Spinrad responded that currently the evaluations are all internal with the main emphasis on mission alignment. The internal dialogue will help ensure successful transition and communication with researchers and end-users. Also, an X2R component is being developed with end-users making requests from researchers.

NOAA Observing Systems Council: Current Status and Way Forward

Manson K. Brown, Assistant Secretary for Environmental Observation and Prediction

Summary

This presentation is in response to SAB interest in observing systems expressed most recently at the SAB meeting in La Jolla. Manson Brown is the Chair of Observing Systems Council and this is an informational briefing with SAB comments welcomed at the conclusion. Some key drivers or imperatives compel NOAA to think differently about observing systems and how we manage them.

- Mission Effectiveness

Observing systems are the foundation for all we do in NOAA. Our essential observing systems are part of America's critical national infrastructure. We must manage essential systems through their lifecycle with a keen focus on reliability, sustainability, and robustness.

- Affordability

To drive towards making our observing system portfolio as cost effective as we can, we must possess an in-depth understanding of the linkages between observing system requirements, the systems themselves, and the downstream mission impacts. We must also understand the landscape of emerging technologies. We do this well on a system-by-system basis. Today, we are less skilled in doing this on the basis of the overall observing system portfolio.

- Adaptability

As the science and technology changes, our observing systems portfolio must be able to quickly adapt. As new environmental threats emerge, we must sharpen our insight about our observing system portfolio's ability to observe those threats. Also, as the future of space for satellite systems becomes more congested, contested, competitive, and commercialized, NOAA must be prepared to embrace concepts like disaggregation and redundancy to mitigate risk from threats such as space debris, signals interference, and cyber-attacks. NOAA is also considering commercial sources to collect earth-observing data.

- Portfolio Integration

Our scientists often say that they've never met an observation that they didn't like. Scientists also insist that we preserve longstanding observational records. There are many good reasons for this. We are skilled at adding requirements and new observing systems to our portfolio. We are less skilled at deciding what systems should be retired so that we can afford those new systems. This challenge calls for more of a portfolio management approach where we can make fiscal and mission impact-based judgments about observing systems on a more holistic and integrated basis. A portfolio management approach should also give us deeper insight into how to strike the right balance between in-situ and remote sensing equipment. An optimal portfolio management regime shouldn't look at observing systems in isolation from their data management systems. Our plan is to begin looking at them as an integrated whole, with the reminder that "Investing in Observational Infrastructure" is one of NOAA's top priorities.

- Portfolio Management

NOAA manages requirements through something we call the Consolidated Observations Requirements List or CORL. We manage systems and capabilities using a process called NOAA's Observing System Architecture or NOSA, and we manage the data sources impacts to

mission using a decision support tool called NOAA Observing System Integrated Analysis or NOSIA II. In recent months, we have transitioned NOSIA II from a pilot project to initial operating capability. Today, our goal is to manage the portfolio in efficient and cost effective ways; tomorrow, our goal is to manage the portfolio in efficient, affordable, integrated and adaptable ways.

NOAA has over 1500 system-independent, mission-based observing requirements leveraged from 257 observing systems, 111 of which are NOAA-managed systems of record. When the NOSIA-II decision support computer tool was conceived some years back, the designers arrayed all observing systems of record against NOAA products and services categorized by performance objectives supporting four mission goal areas: Weather Ready Nation, Resilient Communities, Climate Adaptation, and Healthy Oceans. Against a perfectly performing observing system portfolio, which would score 100%, NOAA assesses our actual overall portfolio performance at 66%. The obvious question here is whether 66% good enough. Perhaps that is all we can afford or we have more requirements than our systems can handle or a combination of both sets of factors. The real power of NOSIA II is that it allows us to isolate individual observing systems and assess the impact on performance objectives and mission areas relative to the status quo. We are using NOSIA II to inform budget decisions and to provide deeper analysis of budget needs to the Hill and OMB and are just beginning to unleash the power of this tool.

Next Steps

NOAA is developing a short and long term plan to better manage NOAA portfolio including transitioning NOSIA II to full operational capability. Per the suggestion of the SAB, NOSC will conduct an annual emerging technologies briefing. While NOAA is doing a good job of managing its observing system portfolio, we recognize the significant imperatives to do it even better and think that integrated portfolio management will help.

Discussion

Lynn Scarlett commended NOAA on development of strategic guidance. Bob Winokur said that was presented was not an integrated system architecture but a conglomeration of architecture systems so the challenge is how to manage a portfolio of architecture and there is no discussion on priorities on the next steps. Bob Winokur said his comment is that what was presented was more of a portfolio management strategy rather than a presentation of integrated architecture. Manson Brown agreed and said it is really about management; he asked initially for a scorecard on health of individual systems, and NOAA staff couldn't do it. NOSC works on giving leadership guidance and about what to invest and divest in. Manson Brown said today NOAA is competing satellites against other components of portfolio but want to compete "like things" against "like things". Mike Kalb asked where science priorities come into the discussion. Manson Brown said all are folded into together, not as a prioritized list but including how operational and research needs are addressed.

Kathy Sullivan said there is a risk that "urgent" edges out "important" and there is no management system that retires that risk. We must keep that factor in play and weighted appropriately. An improved toolkit provides a basis for discussion; it is not a magic tool to provide answers.

Susan Avery said there is a large observational infrastructure outside NOAA such as the university fleet: how is this incorporated into the NOAA process? Manson said the matrix includes academic and international assets. Kathy Sullivan said we took the agency requirements such as Days at Sea and reformulated them to establish precision or spacing to get at this question. In this way a ship can layer requirements and get multiple observations on one cruise. NOAA is in the best condition in the federal government to say what they need measured by ship use, and this will have an impact on ship use and charter in the future.

RADM Score added that UNOLS is one system we track in NOSIA II. Molly Macauley asked about a portfolio approach; often it could be a capability to hedge risk and asked if risk is implicit in your portfolio. Manson said it was; but he wants to do tests on what is out there that can provide other capabilities or in a negative way, such as space debris. Risk is an important component of mission effectiveness.

Louis Uccellini said the Observing Systems Council does set priorities: on the NEXRAD service life extension program decision, NOAA was able to make a case to OMB and Congress in part due to this type of rigorous approach. Kathy Sullivan added that subject matter experts across NOAA were polled on priority of key observing systems; using the results from the polling the data relay package from satellites increased in priority compared to other analyses. We would have missed that information without this analytical look.

Lynn Scarlett said this morning the Board heard about NOAA priorities from Kathy Sullivan, had an update on the Strategic Research Guidance Memorandum from Rick Spinrad and had an overview from Manson Brown on NOAA observing systems. Common topics included increased emphasis on coordination and integration within and out of NOAA and mission alignment. One theme is increasing emphasis on coordination and integration inside and outside NOAA; another is discussions on alignment and how it advances priorities and mission. She asked: What do you see as biggest challenges in coordination and integration, and in furthering alignment? Are challenges internal (cultural or legacy system), or external (Congress, partners)?

Rick Spinrad said NOAA must be deliberate on risk tolerance and we will define risk challenges on portfolio. Another challenge is flexibility to address emerging issues such as Cuba and Deep Water Horizon; how do you incorporate what is tolerable from a resource and budget point of view. Manson Brown said one lesson learned is that political appointees matter, and there are not a lot of them in NOAA. There has been a lot of discussion that NOAA Line Office leadership needs to own these issues if they are going to be sustained over time, as politicals leave in 15 months. Kathy Sullivan added that the political team has established a working relationship with career staff in NOAA to carry these efforts into the future. Dr. Sullivan said the political team has no interest in creating a legacy but wants a bequest to leave NOAA better than when they came in. Craig McLean said, as a career person since 1981, the current policy team is the best he has seen.

Review Report for the Joint Institute for Marine and Atmospheric Research (JIMAR)
Susan Avery, President Emeritus, Woods Hole Oceanographic Institution, SAB Member and Chair, JIMAR Review Panel

Summary
JIMAR was established in 1977; it is the largest cooperative institute as measured in terms of ocean area and its research themes reflect the region's issues that are highly tied to a coupled ocean-atmosphere state. Current research in JIMAR is concentrated in eight themes: ecosystem forecasting, ecosystem monitoring, ecosystem-based management, protection and restoration of resources, equatorial oceanography, climate research and impacts, tropical meteorology, and tsunami and other long-period ocean waves. The JIMAR partnership brings university scientists together with scientists from NOAA's Pacific Islands Fisheries Science Center (PIFSC) and Pacific Marine Environmental Laboratory (PMEL).

Overall, the review panel found JIMAR to be a strong Cooperative Institute (CI) addressing the goals of both the University of Hawaii and NOAA through an active research and education agenda. The transition to a regional cooperative institute over the last few years is now yielding new research results that benefit the region.

The panel gave JIMAR an overall rating of "Outstanding" and made eleven recommendations in their review report, all of which are presented in abbreviated form.

Strategic Plan and Science Management

- Recommendation 1: The University of Hawaii (UH), PIFSC and PMEL should prioritize discretionary resources to be consistent with ideas that emerge from a think-tank retreat.
- Recommendation 2: The review panel cautions against tampering with a Task I funding model that is successful at JIMAR.
- Recommendation 3: NOAA should identify a way to remove or fix the restriction on foreign nationals and integrate international diversity into its labs to best achieve their science mission.
- Recommendation 4: JIMAR should evaluate and determine the best means of making the use of the IRC space to advance contributions that would pave the way to the next generation of fishery science.

Science Review

- Recommendation 5: JIMAR should enhance the zooplankton and ichthyoplankton monitoring programs.
- Recommendation 6: JIMAR should pursue activities to develop a major center of ecosystem modeling for coral and pelagic systems that can be used for diagnostics and prediction.

Education/Outreach

- Recommendation 7: JIMAR should foster mentoring and exchange of ideas among student and faculty.
- Recommendation 8: JIMAR should establish a partnership between the UH-Hilo campus and JIMAR to continue the relationship between NOAA, the fisheries cooperative unit and its pool of undergraduate students.
- Recommendation 9 JIMAR should help students navigate the tricky waters between university expectations and NOAA needs.

- Recommendation 10: Outreach is an unfunded mandate but its impact is very high, so if funding permits, JIMAR should try to expand it in the most powerful ways.
- Recommendation 11: UH should create three tenure track positions in quantitative fisheries to foster development of a novel ecosystem-based graduate education emphasizing the tropical region and its location in the Pacific Rim. In turn, NOAA should match this university contribution through funding integrative science research programs including graduate student support.

Discussion

Mark Merrifield, JIMAR Director, thanked the review panel and said JIMAR agrees with the recommendations. Mike Donahue asked when recommendations go to NOAA and the CI: what is the follow-up? Cynthia Decker responded that the report will be transmitted to NOAA Administrator, and NOAA communicates back to the CI. Based on the score they receive they may be asked to address the recommendations so that is the accountability. Lynn Scarlett asked Mark Merrifield for his perspective on his plan to follow through with the recommendations. Mark Merrifield responded that from an accountability point of view, they will be addressing each of the recommendations; he added that the recommendations give the JIMAR ammunition to go back UH Administration and work for new initiatives.

Rick Spinrad asked about the recommendation to establish a center for ecosystem modeling. He asked if there was any relevant extant ecosystem modeling and why should JIMAR establish a center? Mark Merrifield responded that staff is self-organizing in JIMAR to create an ecosystem modeling system to take into account expertise in Western Pacific and international partners to fill it out. He doesn't know what interaction is planned with NOAA. Rick Spinrad said there may be a way for NOAA to optimize what is going in JIMAR. Susan Avery said there are various types of ecosystems that may involve different models. Rick Spinrad said NOAA can't afford to have multiple models based on geography.

Rick Spinrad said differences in expectations for CIs are an area of tension in other CIs—is it an issue here? Susan Avery said working relationship between UH, JIMAR and NOAA was excellent. It may be because JIMAR is embedded in a college with mission for basic and applied research with awareness that fundamental discoveries can address both creativity in science and utilization. JIMAR has provided opportunities for NOAA employees to get degrees. With the richness of what JIMAR is able to put together with NOAA, the mutual expectations are not as much of a challenge as elsewhere. Mark Merrifield agreed. Dawn Wright added there may be some areas of cooperation with the Cooperative Institute for Marine Ecosystems and Climate (CIMEC) and JIMAR.

Jean May-Brett made a motion to accept the JIMAR review report and Bob Winokur seconded the motion. The motion to accept the report passed unanimously.

Strategy Session

Ms. Scarlett reminded everyone that the effort was about providing an outlook for NOAA for 5-7 years out and to position NOAA to best achieve its mission in the future. The discussion is not a

"how to" or recommendations for structural change. The SAB's role is to create awareness and ask questions.

Opening Remarks for Strategy Session

Dr. Sullivan stated that the idea is to explore things further. What are the ways or alternative ways that NOAA might think about new observations or trends? Who is doing interesting things that might be valuable to NOAA? Where are things that hold great promise? Is NOAA aware of important developments or are there blind spots? Are there certain strategies that NOAA should consider? The SAB should bring awareness and understanding to NOAA.

Panel Discussion with Invited Speakers
Rowan Douglas, CEO Capital, Science & Policy Practice at Willis Group

Summary

Mr. Rowan Douglas stated his goal was to discuss the interface between capital and science and explain how NOAA's work has been a great influence on capital by creating information that can lead to resiliency. He had been head of analytics and handled risk for re-insurance companies. It had become clear that the company's goals would require understanding the changing world to create resilient platforms, sustainable growth and support human dignity. He suggested that now is a new "romantic period" when economics is reconnected to nature.

In 1992 after Hurricane Andrew the need for resilience was clear. For 300 years things had been as they had been and then there was a crash. It was realized that insurance could not be done in the old way, because the risks had changed. New smart capital efforts address risk in a new way. Now, resilience is getting better. Engineering companies were critical to leading towards resilience. Capital people were forced to look at models. An important question was what should be the risk tolerance of an insurance policy. Should it be 1:10,000 like a nuclear plant? It was decided insurance should tolerate a 1 in 200-year loss in a year. Therefore, insurance companies to be more resilient allocated more capital to Mother Nature and made money. As a result, after Hurricanes Katrina, Rita, and Wilma, although there were huge losses, the system/market was resilient, because capital had been set aside. In 2011, global loss from natural disasters neared $121 billion, but prices did not go up because the companies were ready and had a one in 12.5 year return period. It was important to determine the return period of pricing risk. Science is fundamental in this process by modeling potential current risks. This is not about what might happen in the future; it is about what is happening now. The risk has been integrated into accounting and credit ratings.

The Financial Stability Board of the G20 was set up after 2008 financial crash to avoid any such crash again. In September 2015, the G20 board was curious how stress tests could be applied to economic systems and recommended a task force for developing stress tests for economic systems.

There is a need to understand the manmade environment. The risk is about the extremes and the stress points of the system. The extreme rare events need to be annualized and accounted for routinely. It was estimated that the company Swiss Re had $31.9 billion as the risk of extreme events in 2013 and, therefore, in order to build resiliency, needed $20 billion in capital to insure.

A Royal Society Report on Resilience to Extreme Weather concluded that "the re/insurance sector has made considerable progress in evaluating the risks posed by extreme weather." These risks now need to be better accounted for in the wider financial system, in order to inform valuations and investment decisions and to incentivize organizations to reduce their exposure. This could be done through a requirement for public and private sector organizations to report their financial exposure to extreme weather at a minimum of 1 in 100 (1%) per year risk levels.

Discussion

It was pointed out that 100-year storms are based on historic records. But the more dramatic storms are becoming more common and SAB members wondered how the changing baseline is being incorporated.

Mr. Douglas responded that the 1 in 100-year storm is far from stationary, and the insurance sector has to embrace that, because hundreds of millions of dollars are on the line. Insurers have not found a better metric than a 100-year storm, but there is some acknowledgement that the metric is changing very fast, and there is a need for society to understand that fact. Also, he reminded the SAB that it is the extremes that matter and, therefore, the extremes must be managed. It could be a storm, a water stress issue, etc., but the extreme of a few extra kilometers per hour in a wind storm is hugely costly. Often, climate is reported in a mean, but risk management is really about the extremes.

In response to the topic of public risk communication, Mr. Douglas stated that he is not an expert on communication, but has observed that a true way for people to see risk is in bank accounts and how risks impact financial decision making. People are slowly becoming more sensitive to these things. However, he acknowledged big changes may not happen until the US has a few more Category 4 or 5 hurricanes in the wrong places and then things will all begin to change. There was a question about abrupt change, tipping points and the variability of extremes and how the insurance community responding. Mr. Douglas responded that the big tipping points are not being actively considered, because most insurance policies are short contracts of about 1 year. Therefore, it makes tipping points and thresholds less important for insurance companies. The variability is more difficult and is an important area to consider.

It was asked if a robust re-insurance industry could lead to people taking greater risks.

Mr. Douglas responded that people in the US demanded insurance after catastrophic fire and weather events in the 1870s, so they could have more resilience and could carry on after large losses. After an insurance code was created, the rules of capital started to influence urban development, and the encoding of resilience into capital can lead to human benefits. Resilience becomes a responsibility of those in charge, but until metrics exist, it is difficult to create legal framework. However, once the metrics have been established, actions for resilience can take place, because events become not "acts of God" but predictable phenomena. For example, Amtrak recently took out $300 billion catastrophic bond for storm surge, which was possible because of NOAA storm surge data. Financial instruments are possible because earth observation tools are in place.

It was asked what type of global observing or tools are currently unavailable that would be useful to the re-insurance world. Mr. Douglas responded that the modeling and information platforms

have turned scientific information into knowledge for decisions. Modules for risk assessments have been developed with much discussion about the assumptions. Companies are actively working to move from models to interactive platforms for catastrophic risk analysis. However, they are limited in only covering only half the world. There is a need to expand the understanding of extremes in the system, keeping in mind that managing extremes is not just about intensity, but duration and frequency of current risks. NOAA's primary value will be in helping to define key comprehensive metrics to define climate risk. Climate risk depends on attributes of property. This effort to define climate risk is not only about re-insurance, because, in the near future, catastrophic risk assessment may become a mainstream consideration.

He mentioned that natural capital and ecosystem service values are currently missing from the spreadsheets, and there is a need for tools that put those values back into the system. There are real costs to the economy when natural capital is not part of the equations. Therefore, it is important to find a small number of metrics that would include these values in spreadsheets. Many decisions are long-term decisions, especially about infrastructure. There should be a calculation that includes natural capital and the cost to infrastructure if the natural resource is not there. These natural capital calculations should be done at the front end of the decision making process as the finance plan is put together.

Mr. Douglas expects these calculations to become more main stream after the creation of the G20 task force that will likely be called Enhanced Disclosure Task Force for climate and natural disasters. He predicted risk reporting related to climate and natural disasters will become commonplace and will result in an increase in capital charge for higher risks. Capital charge is the amount of capital a regulator demands one to have on hand, because of the risk. The insurance companies do the calculations. This reporting requirement will lead to changes in behavior that demonstrate resilience.

In terms of communicating risk, Mr. Douglas acknowledged it is important to pick a level of risk that people can relate to and is not in the too distant future. There is not one right answer, because different groups have different levels of sensitivity to risk.

The ultimate community product is the 10% everyone pays on top of their insurance into a global fund up to $500 billion per year for reinsurance and every time there is an event, some of the fund goes to pay for the event. People begin to care about risk and are motivated to act when it is tied into the financial system. Human dignity results from linking environment and capital.

Richard G. Baraniuk, Victor E. Cameron Professor of Engineering, Rice University

<u>Summary</u>

Dr. Richard Baraniuk began by stating that NOAA does a lot of sensing, and he wanted to talk about revolutions in the design of environmental sensors. There is a new approach to sensing called compressive sensing, which exploits the fact that there is a lot of redundancy built into sensors today. There are a couple of big challenges with data today, one being that data are too expensive, for example, consider a MRI machine and image. The other problem is too much data. It is possible to produce terabytes of data/second but no way to send the data. However, new mathematical approaches can address both problems and compressive sensing is a key idea.

There is a lot of redundancy in our measurements. There is smoothness that can be exploited to save on sensing. There is a need to rethink the approach to sensing; sensing needs to be done randomly, and appropriate mathematical techniques can provide the same amount of information. There is mathematical proof that information is not lost with reduced sensing, but this approach does require an "unjumbling" process, which trades costs of sensor development to costs of computations. Computation is getting cheaper and sensors are getting more and more expensive.

Dr. Baraniuk's group built single pixel camera that focuses light onto array of mirrors and can therefore reduce the number of samples, reduce sensor costs dramatically, and reduce the amount of data, but not the amount of information. Insights on sensor development can be transferred from mathematics to engineering.

Dr. Baraniuk transitioned topics to education and textbooks. The textbook industry has problems for a number of reasons. First, it takes long time to develop textbook and many fields are fast-moving. In addition, traditional textbooks are focused on a single subject, and true multi-discipline textbooks are rare, but are becoming increasingly important. Finally, there are extreme costs of educational materials leading to trillions of dollars of student debt with books equal or exceeding tuition.

The goal was to create a different way of writing and distributing books that exploited network effects in education and knowledge sharing. The program is Open Educational Resources (OER) with the basic idea to rethink the book and provide pieces to be put together for the personalization of learning. OER has an open source licenses and gives people a platform to house educational materials and publish online. Anyone can contribute and currently there are 27,000 content blocks to use to develop textbooks. Also, currently there is a built library of 25 textbooks called OpenStax College that have been taken up by community colleges, high schools, and 1 in 5 degree granting institutions in the US.

Discussion

Dr. Baraniuk stepped back from the word "smoothness" and instead used "model" when speaking about compressive sampling. If there is a good model, it could be smooth or a differential equation. Randomness as a universal sensing strategy is guaranteed to work with a model.

Dr. Baraniuk addressed questions about applying compressive sensing applies to sensor networks stating that currently the standard way to design a sensor network is to follow results from the 1930s, which places the sensor close together. Compressive sensing however says just randomly place the sensors. He added that compressive sensing can be applied to expensive hyperspectral sensors with massive amounts of data. There is work being done on cameras where pixels and wavelengths are scrambled and then computations pull out 3-D hyperspectral image. He added when considering sensors whether in space or ARGOS floats science it is important to look at the cost of total system and the impact that the sensor package has on that cost. Sensors can be an expensive part of overall system.

As there is a movement to smaller satellites, the sensor design could start to dominate costs and compressive sensing could help reduce sensor costs. Compressive sensing has been tested by

France on astronomical satellites. Cost savings comes down to the model and really powerful models have been developed. Making decisions about compressive sampling requires knowing the resolution of interest and the number of measurements necessary and then the completion of a sensitivity analysis. Low signal-noise systems might not be appropriate, because there is a tradeoff in the signal-noise ratio. Compressive sampling is a good approach with multiple models. Models can link between multiscale methods using wavelets for image data and fluid dynamics. Also, it is possible through compressive processing to recover image that can be compared to records from past. Legacy data that allow the observation of trends would be keys to recover the kind of compatible data through back-calculation.

Dr. Baraniuk responded to questions about the OpenStax College textbooks, stating that the goal was to create a platform to build interdisciplinary experiences. People are starting customization that includes the creation of true interdisciplinary textbooks. For example, some faculty and programs are interested in connecting across a range of disciplines, including things like geography and economics, which makes education more exciting and relevant. He thought NOAA could foster people working together to create new discipline textbooks such as Environmental Intelligence.

He added that quality control for the OpenStax material is post-publication. Anyone is allowed to upload material, and initially it is not controlled quality. The completed textbooks available had professional societies put the textbooks through their reviews process. The books had professional authors, multiple rounds of peer review, and classroom testing. He also clarified that OpenStax works in some ways like a publisher and is supported by foundations that like to invest in books more than scholarships, because it helps maximize the return on investment (ROI). Currently there is a network of 38 companies that help with sales and give some services. The books have some mission support fees that will help support future efforts.

October 30, 2015

Continuation of Strategy Session
Invited Speaker: Marcia McNutt, Editor in Chief, *Science,* AAAS and Nominee for President, National Academy of Sciences

Summary

Dr. Marcia McNutt started by saying she will focus her thoughts on meeting NOAA's future mission with science and technology on three critical elements of NOAA's mission: weather and climate predictions, weather-related hazards warnings and risk mitigation, and ocean ecosystem protection and fisheries management. It is important to think about the culture of NOAA as it embraces technologies today and the cultural change that must take place to embrace the future. A good example is NOAA taking its identity from large ships and major satellite platforms. They may not be the solutions to the mission in the future. The workforce needs to be prepared to let them go.

CubeSats are cheap, miniature satellites. There was a time when satellites were getting bigger and more expensive, such that they required international agreements to build and deploy. Now

CubeSats are using proxies to measure a broad suite of observations and calibrated sensors for gathering the data researchers really need. This new technology could have a big impact on how NOAA gets data. In the near future it is an important to cross-calibrate legacy data with the Cubesat data sets in order to avoid data discontinuities between observing technologies.

Social Media is changing how agencies are interfacing with the public. In early 2010 after the devastating earthquake in Haiti the first USGS indication of the earthquake was via a Tweet. That event motivated the USGS to create TED (Twitter Earthquake Dispatch), which uses many languages to look for indications of seismic activity. Also *Did you feel?* is a website by USGS that uses crowd sourcing for an earthquake "felt zone". It had real impacts and convinced many states in the New Madrid fault zone to take earthquakes seriously.

In the future, there will be high-speed internet everywhere for everyone, and this will change approaches to NOAA's mission success. She asked the group to imagine everyone's cell phone as a climate sensor with the data always available. It will be possible to crowd source things like the first day of flowers blossoming and the first day of leaves turning color for climate data. Another major trend is that the cost of bandwidth is quickly decreasing, which makes it much easier to move data around. Also, the power of computing is growing quickly. In 2010 computational power was equivalent to the intelligence of a mouse. By 2023, processors will rival the intelligence of a human brain, and by 2050, a computer is projected to have the intelligence of the whole population. This has important implications for how NOAA can achieve its mission. Dr. McNutt pointed out that the 2015 Ocean Mapping X-Prize has NOAA as a partner with the goal to enhance autonomous capabilities underwater. The question is once the mapping mission is complete what will be the next mission for the assets.

Discussion

It was asked how NOAA should be using social media or other technologies in the near term. Dr. McNutt responded that social media can be used in many ways. NOAA could create a coastal flooding media site and have people report their flooding experiences. She feels that many people are not connecting their own personal flooding experiences with a regional, national, and global phenomenon. It would be powerful for people to see how many people are involved in an event. Social media is powerful, because people take some ownership and then explore the data in a different way. This allows people to better understand the extent of event impacts. Other ways social media might be useful is in the area of hazards and getting warnings out to people. Social media might be a better way to warn people. Hurricane Patricia went from a tropical storm to a Category 5+ in less than 30 hours and that was something never seen before. Could this be something more common in the future? How could social media help in situation like Hurricane Patricia, which might make traditional warnings less effective communication tools?

Examples of NOAA crowd sourcing were discussed including mPING (Meteorological Phenomena Identification Near the Ground), the crowd sourcing app that is used to improve

algorithms of NEXRAD radar. It was acknowledged that mPING can be expanded. Dr. McNutt added people reporting things such as flooded roads in real time can save lives and navigation programs should want that information and make it a high priority. It was added that apps like Waze, Google, and Apple maps are becoming intermediaries in data sharing and quality control and could be part of the weather ready nation priority. Also, new technology allows windshields to be designed to take in environmental data making it possible to eliminate the human interaction and have automated crowd sourcing. It was acknowledged that automated capacity of crowd sourcing is powerful, but it is also important to involve citizens because the reporting connects the individuals from across the country to the process and increases individuals' interest in the science and information.

National Ocean Service (NOS) is considering crowd sourcing of bathymetric information. Currently, the mapping community tends to be risk averse and worry about data quality control, but they should find a way to overcome their hesitation.

The presentation highlighted the importance of social media and crowd sourcing for potentially providing warnings. However, it was acknowledged that individual response to hazards is very complicated leading to discussion about collaborative decision making as a tool. Dr. McNutt responded that there is great importance in really integrating more social science into what we know about the changing conditions under which people are going to have to operate. The science is strong, but still could still use more environmental data on a finer scale to better understand regions and how to manage resources. There is a need to do more social science experiments and test which communication tools are most effective.

It was asked how NOAA should adjust its portfolio to help the move towards resiliency acknowledging that means economics and social science. Dr. McNutt responded that NOAA has done a pretty good job. She felt NOAA moved through logical steps of first focusing on storms and tornados in particular to better understand the conditions that create them. The next step was to work with engineers to define what is necessary to design structures that will not fail and then, change building codes. NOAA could help define where safe shelters should be as a next step. In terms of fishing communities at high risk because of climate change she said that might be a good next problem for the economists.

There was a question about the cost performance of information, which makes it possible to just continue with a brute force sensing with more and more information or should sampling be more refined. Dr. McNutt responded the first step is to determine the questions that are trying to be answered. CubeSats are imaging Earth at 5m resolution or even finer. They can look at an individual farm field and say the field looks a little dry and there should be irrigation. This high resolution is necessary to answer some questions.

Dr. McNutt was asked about ocean science, explorations, and ocean predictions and her sense about private capital in ocean exploration and any groups that are really advancing the field and that might be leading in cogitative computing and ubiquitous (swarm) sensing.

Dr. McNutt stared with private capital and stated she is a fan of the David and Lucile Packard Foundation and Gordon and Betty Moore Foundation money that has been put towards the ocean. They have done a good job for taking risks developing new technologies. The Moore Foundation has supported a lot of good people doing work in the microbial ocean. Schmidt Ocean Institute is starting to have an impact. They provide the ship time and ship personal for people who can afford to come and use those platforms. Schmidt Ocean Institute has also done work with open data.

Dr. McNutt moved on to ocean prediction and stated the community might be on the verge of a major understanding of meso-scale type prediction. For example, in the near future might be able to say there is a heat anomaly in the Indian Ocean and understand how that relates to future rainfall in the next few years in another area. Currently, under sampling prevents the understanding of the movement and development of these phenomena. We need more observations from 1000m to the surface of the ocean. Ubiquitous sensing has been used in the open ocean for physical variables, but not with biological sensing or chemical sensing beyond salinity.

Cognitive computing's role in the environmental sciences is going to be big. It might play a role in hurricane forecasting or climate projects. She added that cognitive computing needs to be kept close to the science so it does not just become pattern recognition software. The future with climate is becoming less stationary and therefore would increase pattern recognition errors.

Review Report for the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS)

Jean May-Brett, SAB Member and Chair, CIMMS Review Panel

Summary

CIMMS was established in 1978 at University of Oklahoma (OU) and is located at the National Weather Center (NWC) in Norman, Oklahoma. CIMMS is a Research and Development Partner located in the National Weather Center, where CIMMS serves as a catalyst for outstanding scientific exchange between university and NOAA scientists. University support for CIMMS has progressed over time and was well documented in the materials provided to the review team. The panel strongly supports a request to the University administration for a commitment to continue a return of funds from the indirect category to CIMMS to allow for independent research in response to new opportunities and "bright ideas" in support of further promoting the outstanding research and development of the CIMMS scientists and their university colleagues. CIMMS is sponsored by NOAA's Office of Oceanic and Atmospheric Research (OAR) and is a strong partner with a number of NOAA programs in addition to programs located at the NWC.

Research themes include: weather radar; stormscale/mesoscale modeling; forecast and warning improvements; climate change and extreme weather events; and societal and socioeconomic impacts of high-impact weather systems.

The review report includes a number of recommendations.

Strategic Plan recommendations include:

- Selection of a new Director needs to be made swiftly for CIMMS to stay in alignment with NOAA's strategic plan
- Re-energizing the strategic goal on climate change.

Science Review recommendations include:

- Expansion of partnerships with OU faculty, investigators from other NOAA CIs, EMC, ESRL, NASA, Visiting Scientist programs, and collaborations with other Universities to further the growth of storm-scale satellite/radar/lightning data assimilation techniques.
- Exploration of the potential utility of developments in disciplines beyond the atmospheric sciences, such areas as data mining and machine learning.
- Consideration of the possibility of enhancing Hazardous Weather Testbed participation through the use of parallel experiments at remote sites, such as universities and other agencies, and possibly expanding the focus to include evaluation of storm-scale data assimilation efforts, which are similarly parallel and uncoordinated.

Science Management recommendations include:

- Establishment, within CIMMS and the university framework, of job titles that distinguish between degrees of seniority and achievement.
- Establishment of a mechanism that recognizes contributions by CIMMS and CIMMS personnel and other achievements publicly.
- OU should consider providing faculty lines to CIMMS, from the relevant disciplines within CIMMS, where the primary alignment is with CIMMS rather than a department. These lines should be geared toward establishing collaborations both within CIMMS and with departments at the University. Also, interdisciplinary research should be promoted and rewarded, through some internal funding or other support mechanisms

Education and Outreach recommendations include:

- Expansion of education efforts to the K-12 population, perhaps by exploring participation in the Oklahoma Science, Technology, Engineering and Mathematics (STEM) network. Opportunities include module development for project-based learning or participating in local school district events.
- Expansion outreach efforts beyond the local area, perhaps utilizing the recent communications specialist hire to develop a plan for greater outreach efforts.
- Expansion of participation in education and training activities beyond the traditional NOAA forecasters, possibly distributing data and tools or providing remote access to outside Universities and other agencies.

The review panel unanimously agreed to a performance rating of "Outstanding" for the CIMMS review.

Discussion

Walleed Abdalati, a member of the CIMMS review panel, emphasized great job that Randy, Tracy and Sebastian are doing in CIMMS in absence of a permanent Director.
Laura Furgione said NWS has had strong partnership with CIMMS. She wondered if there could be best practices noted that could be emulated at other CIs.
Rick Spinrad said Waleed Abdalati is chair of CI Directors Executive Committee and NOAA is trying to include those best practices.
Michael Donahue asked about the recommendation to reenergize climate change strategic goal. Jean May-Brett said the previous CIMMS Director led this effort and the position has not yet been filled. Randy Peppler agreed and added that most of this research on regional climate diagnostics variability was former Director Pete Lamb's work and meant to strengthen links between climate and extreme weather events; there is no NOAA direct funding to support this work.
Rick Spinrad asked about the hazardous weather testbed and wondered if there was a downside in expanding that capability. Mike Baldwin said the recommendation is to increase participation from education and outreach to get to university and more students and also to have a bigger sample size, with more forecasting experiences and data sets available.

Molly Macauley asked about societal and socioeconomic impacts. The FACETS program looks at the warning process from forecast to the communication with the public, involving social scientists from OU. Molly Macauley asked if there was a concern by the panel that investment from OU was not commensurate with NOAA funding. Jean May-Brett said largest sum of money to university is the CI and the scientists are not being recognized through projects and awards and OU should provide higher visibility. Molly Macauley asked how this message gets shared with University. Jean May-Brett said this could be presented as a potential opportunity to leverage NOAA investments.

A motion was made by Bob Winokur to accept the report; it was seconded by Michael Donahue and approved unanimously.

Update on NOAA Cooperative Institute Review Process
Cynthia Decker, Acting Director, NOAA Cooperative Institute Program Office

Summary

The purpose of this presentation was to discuss the CI review process and potential changes so that the SAB can give some feedback. Cynthia Decker provided background that Cooperative Institutes receive an initial 5-year award and are reviewed in year 4 of that cycle. The outcome of this review determines if the CI gets a second 5-year award. CIs are accountable for recommendations from the review: some are to improve operations, others are aspirational and some review reports include recommendations to NOAA.

CI review policy

In preparation for an update of the CI review policy, a survey was done in 2014 of CI Directors, administrative staff and Review Panel Chairs to provide input to process changes. Based on an analysis of past reviews and the input from the survey a number of changes were proposed.

Changes include additions to aspects considered under the Review Focus Areas:
-adding scientific integrity and risk tolerance to the Science Management Focus Area.
-adding metrics for success, information on students and post-docs, and diversity to the education and outreach Focus Area.

Changes were also proposed in rating and scoring options. There will be a numerical score with weighting of 40 points for Science Accomplishments Focus Area and 20 points each for the other three Focus Areas (Science Plan, Science Management, Education and Outreach). To the qualitative rating levels, there is a proposed fourth level, "significantly accomplished" to the previous three levels of Outstanding, Satisfactory and Unsatisfactory. This level will be between Outstanding and Satisfactory. Descriptions under each of these rating levels were adjusted to reflect the new scale.

There were additional recommendations from survey results that are proposed for the revised review process: more guidance to the review panel prior to the review, including the administrative review within the overall CI review, and increasing time available for stakeholder, student and staff interaction during the review.

Next steps

Next steps include: incorporating SAB feedback and direction, review by the CI Committee and approval by NOAA Line Offices, presentation to the Research Council for approval; revision of CI Handbook and issuance of new guidance to CIs and implementation in new review cycle (FY 2021) or by the Cooperative Institute for Research in Environmental Sciences (CIRES) as a pilot demonstration.

Discussion

Michael Donahue said he was pleased that this was happening but does not think the changes have gone far enough, suggesting that the proposed rating of Satisfactory should include achieving all goals to some degree. He also suggested that the NOSIA-II approach to ratings may be something that should be considered for CIs as it includes numerical ranking as well as a summary ranking. Cynthia Decker said she will review the NOSIA-II rating process and if there is a significant change made in the CI review process, she will ensure that the revised draft will be shared with the SAB again.

Bob Winokur suggested that metrics for Science Accomplishments would be a good idea; he also was not sure what is meant by risk tolerance. Bob Winokur also did not see anything in the process about CI funding and determining if a CI is underfunded for what it is doing. Cynthia Decker responded that the review panel gets information on funding but funding is not assessed

as part of the review; the proposed level of funding may not be the same as actual funding but it is included in the review presentations. Rick Spinrad said NOAA wants to make sure that the expectations in the proposal are reflected in what they review four years later. Science Accomplishments include traditional accomplishments; NOAA may want to add more. Risk tolerance is not prescriptive but there is no explicit discussion of risk tolerance about comfort level of NOAA and the CI.

Kathy Sullivan said proposed ratings include language clarifying what the consequences are of rankings on ongoing funding and renewal. Michael Donahue asked if any thought was given to a probationary period halfway through the 5-year renewed period to see if improvements were made. Cynthia Decker said the NOAA Grants Management Division was not supportive of a shorter renewal but there could be a Special Award Condition added to the new 5-year Cooperative Agreement if there was a specific issue to be addressed. Rick Spinrad said one proposal under CI21 is for NOAA to set up a Contracting Officers Technical Representative for each CI and they would be the focal point for this.

Lynn Scarlett said Cynthia Decker will consider comments heard today and make changes in a revised document, if they make sense to the CI Committee and the Research Council. She asked if the SAB should review a revised document.

Rick Spinrad recommended that NOAA redraft the review policy and, if there are significant changes from what was presented at this meeting; NOAA will send it to the SAB for a virtual review before continuing with the rest of the review process.

Gulf Coast Ecosystem Restoration Program Advisory Working Group (RSPAWG) Report on the RESTORE Act Science Program's Performance Metrics Plan and Coordination Plan

Robert Dickey, University of Texas at Austin and Co-Chair, RSPAWG

Dr. Robert Dickey was presenting on behalf of the Gulf Coast Ecosystem Restoration Science Program Advisory Working Group (RSPAWG, which prepared the report, "Comments and Recommendations on the NOAA RESTORE Act Science Program's Performance Metrics Plan and Coordination Plan". The charge to the RSPAWG was to review the draft NOAA RESTORE Act Science Program's Performance Metrics Plan and Coordination Plan and to submit initial review comments and recommendations.

The report had four overarching comments. First, it is critical to define how NOAA is to measure the performance of RESTORE Act activities as a precursor to planning coordination and collaboration within NOAA and with NOAA's external RESTORE Act partners. Second, the Performance Metrics Plan must be revised to include both quantitative and qualitative metrics assessing the magnitude, quality and impact of long-term outcomes of the Program. Third, the Coordination Plan must address coordination and integration efforts both within NOAA and among NOAA's external RESTORE Act partners. Finally, the two plans must be strongly and clearly integrated to ensure that performance assessment and coordination promote the best available science and development of decision-support tools for a broad range of end users to support both the RESTORE Act's vision and its mission.

Discussion

The importance of performance metrics was acknowledged. It was noted that some of the proposed metrics state the need to measure improvements. Therefore, it will be necessary to have a way to measure the amount of change and it will be critically important to have applicants clearly state what they hope to improve. It was also encouraged that third parties assessment in the metrics be used, because it increases credibility. It was also suggested that efforts be put towards creating strong metrics for coordination as that might be incredibly important for overall success.

Dr. Dickey agreed that strong coordination metrics are important and added that the RSPAWG report has suggestions on metrics to assess and measure the level of collaboration and coordination both within a research consortium membership and between disparate consortia.

Jean May-Brett motioned to accept report and Dawn Wright seconded it. The report passed unanimously.

Working Group Issues for Discussion

Each Working Group (WG) had an opportunity to present to the SAB.

Ecosystem Sciences and Management Working Group (ESMWG) Summary

Dave Fluharty stated that it has been invaluable to be at the SAB meeting as a co-chair. The ESMWG has not had SAB liaisons able to attend meetings in many meetings. Ms. Scarlett said she would consult with acting SAB director Dr. Turner on the liaison and get back to the ESMWG. [N.B.: Subsequent to the Oct meeting, Michael Donahue volunteered to be a SAB liaison to ESMWG and attended their November meeting] Dr. Fluharty added that ESMWG had been asked to look into developing a subcommittee on corals and will come back to them on new members during February teleconference.

Data Archive and Access Requirements Working Group (DAARWG)

Chris Lenhardt said he really enjoyed sitting in on the SAB meeting. There are also vacancies coming up for DAARWG and he would be happy with suggestions from NOAA and the SAB. Ms. Scarlett suggested that DAARWG send to Dr. Turner the current criteria for members that DAARWG is considering and the SAB could give suggestions.

Wrap-Up Discussion

Dr. Sullivan said these discussions will help design the next steps for the SAB and for NOAA. An example is NOAA watching the cubesat systems. It was stated by Dr. McNutt that this is a golden era for cross calibration and should NOAA be doing that now while the legacy system is up and running.

Dr. Sullivan thought the discussions are meaningful enough that the first afternoon of all SAB meetings will be strategy discussions and they will be mandatory for AAs and senior scientists.

It was pointed out how important Mr. Douglas' addition to the conversation was and he gave a different story about the global implications of climate change. He made it clear that the sound science needs to be interacting with a variety of industries including the insurance industry.

Ms. Scarlett, Dr. Spinrad, and Dr. Sullivan will discuss how to incorporate the discussions to date into documentation

Review of Actions
Elizabeth Turner, Acting Executive Director, SAB

SAB approved the consent calendar which included extension of terms for one year for three members of the ESMWG.
SAB approved the Review Report for the Joint Institute for Marine and Atmospheric Research (JIMAR) which will be transmitted to NOAA.

SAB approved the Review Report for the Cooperative Institute for Mesoscale Meteorological Studies (CIMMS) which will be transmitted to NOAA.
SAB approved the Gulf Coast Ecosystem Restoration Program Advisory Working Group (RSPAWG) Report on the RESTORE Act Science Program's Performance Metrics Plan and Coordination Plan which will be transmitted to NOAA.
SAB members will send speaker and topic suggestions for upcoming meetings to Beth Turner.
SAB members will send feedback on CI Review Process to Cynthia Decker. The SAB comments will be incorporated and, if there are significant changes, a new draft will be circulated.
SAB office will follow up with Richard Baraniuk for the bibliography of some interesting examples of compressed data successes and will share it with the SAB. (completed)