NOAA SCIENCE ADVISORY BOARD

NOAA SCIENCE ADVISORY BOARD REPORT ON PUBLIC-PRIVATE PARTNERSHIPS

PRESENTED TO THE NOAA SCIENCE ADVISORY BOARD

BY THE SAB SUBCOMMITTEE FOR PUBLIC-PRIVATE PARTNERSHIPS

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NOAA Science Advisory Board Report on

Public-Private Partnerships

For SAB Review 3/20/2024

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Executive summary

Public private partnerships (P3) provide NOAA the opportunity to address grand challenges by realizing innovation benefits faster than internally-driven technological development alone. NOAA already recognizes the value of public-private partnerships (P3s) in achieving collaborative development, employing a Technology Partnerships Office that focuses on Cooperative Research and Development Agreements (CRADAs) to share government facilities, intellectual property, and expertise. To help NOAA enhance this culture, the Science Advisory Board formed a P3 Committee to examine ways that NOAA can further help the private sector flourish in emerging areas that are consistent with NOAA's mission and plans.

The Committee examined aspects of P3 relationships for two years, holding discussions with experts and industry representatives. The Committee focused more on relationships than financial aspects of P3, recognizing that successful P3s involve engagement through support, feedback, and sharing of technical and business processes. The Committee developed four core recommendations:

1) **Clarify NOAA's future directions so industry can identify investment opportunities**

   NOAA has developed a mutually supportive relationship with the private sector weather forecasting community. There is opportunity to expand that model to other areas within NOAA's mission, such as Space Weather, Climate Services, and Coastal Management. Key to this, is clarifying NOAA's future directions with enough specificity for investors/developers to understand where untapped opportunities exist, and where they do not**.** The report provides recommendations for how NOAA can share information and answer questions in a way that spurs industry to fill needs and avoid duplication.

2) **Enhance a nurturing environment for fledgling technology**

   NOAA has several mechanisms for engaging industry in technology development, but these do not typically address what happens after the initial phase(s) of investigation or development. NOAA should help its partners beyond the initial investment phase, often referred to as "crossing the valley of death". These mechanisms should include identification of Project Champions and workshops to share progress with potential next-stage investors and buyers. NOAA should also seek a mechanism, like DARPA as a Technology Accelerator, to stimulate and drive innovation in areas that align with NOAA's mission.

3) **Promote industry standardization to foster adoption of innovative technologies**

   Widespread adoption of novel technologies is often dependent on standardization within an industry, as variable results from different providers create information barriers. There are many entities NOAA needs to engage to achieve technology standardization. NOAA does well in coordinating its research with other federal agencies, but could do a better job with entities such as States and industry trade

groups. NOAA should strengthen partnerships with these groups and develop a hand-off strategy, seeking to be the trusted partner that facilitates collaboration, rather than being the primary entity responsible for standards creation.

4) Leverage relationships with other Department of Commerce agencies

NOAA resides within the Department of Commerce, which provides unique opportunities to facilitate Public-Private partnerships. Several sister agencies within the Department have missions to encourage private industry. NOAA should engage these agencies to help make connections that are of mutually beneficial and assist their private partners succeed.

These recommendations aim to foster an innovative environment within NOAA that creates strong partnerships with external entities, bringing new technologies to NOAA and the market where they align with NOAA's mission. The Committee believes that implementing the report's recommendations will foster a more effective public-private partnership program.

Introduction

NOAA's Science Advisory Board established a short-term working group to review and assess the administration's level of engagement with public-private partnerships (P3). The review was conducted over 24 months by gathering insights from interviews and internal discussions amongst the SAB member participants. Periodic updates were presented to SAB and NOAA leadership for their feedback and direction.

To understand how to help NOAA engender more - and more effective - public-private partnerships, the P3 Committee investigated additional methods and practices for NOAA. The group began its work in January 2022 and established its focus to include:

- clarifying NOAA's role
- lessons learned
- collaborative data collection
- complimentary planning for future services
- engagement in public decision processes
- workforce development
- shared technology development
- transitioning of NOAA-developed technologies into routine application

Over the next two years the P3 Committee held discussions with numerous industry representatives and interviewed 12 guest speakers, including P3 experts from within NOAA, federal P3 experts outside of NOAA, sister agencies in the Department of Commerce, and private industry P3 experts, and explored other agency approaches (e.g., DoD). In conducting its work, the Committee interpreted the private portion of P3 broadly to include any non-federal entity – universities, non-governmental organizations, local governments, and private industry.

Observations

NOAA has a long history engaging and supporting research and development. However, meeting the grand national and global challenges that fall within NOAA's remit will require catalyzing relevant participation from private sector entities through effective engagement and partnerships. NOAA should work with others to identify problems to be addressed, challenge academia and private industry to find solutions, and as appropriate be part of the testing and certification environments as an impartial entity that validates technology and helps create an on-ramp to its use.

The P3 Committee recognizes that NOAA already does some of this, especially through funding programs. However, the Committee thinks developing a stronger culture of innovation requires NOAA to have deeper engagement with partner organizations, greater clarity of need, and self-restraint as it pertains to NOAA's principal role and mission. This will allow the private sector to

flourish in emerging areas, evolve a greater commitment to nurturing new technology, and create the handoffs that permit innovations to become operational. These steps will increase the likelihood that investments made will achieve market purchase and solve pressing social and environmental issues.

Public-private partnerships (P3s) provide varied and focused opportunities for collaborative technological development, often without providing funding. NOAA already recognizes the value of P3s and employs a Technology Partnerships Office dedicated to achieving collaborative development primarily using Cooperative Research and Development Agreements (CRADAs), in which NOAA can share government facilities, intellectual property, and expertise in collaborative interactions to help create useful, marketable products for public benefit.

Not all new technology that comes to or winds its way through the agency will succeed. Conversely, witnessing a trajectory of successful on-boarding of new technologies over time will be an important performance metric. Success will increase if NOAA concentrates not only on strengthening existing programs, but also engages more deeply with its partners across the entire development chain, addresses NOAA's internal impediments to risk taking, increases commitments to resourcing engagements with outside partners important to NOAA's mission, and commits to sharing risks of technology important to NOAA's mission.

Throughout its work the P3 Committee focused predominantly on the relationship aspects of P3 and less on the financial aspects. It recognized that successful P3s are relationships of engagement that include support, feedback, and sharing of technical and business processes. It also recognized that technology and innovation are simultaneously scientific, cultural, and economic. All three aspects are important for success. The Committee believes a powerful P3 will address the cultural aspects of innovation as well as the financial strength and necessary business / market development required. Attention to all of these by NOAA increases the likelihood of the innovation's success.

The P3 Committee identified four places along the development path on which to focus its recommendations:

1) **Clarify the public and private roles:** Identify the marketplace activity and clarify NOAA's future directions to fill unmet needs with enough specificity so partner- investors and developers easily understand where untapped opportunities exist, and where they do not.

2) **Enhance a nurturing environment:** Help external researchers and technology developers beyond the initial investment phase (such as beyond an initial program or grant), often referred to as "crossing the valley of death" for new technologies.

3) **Develop standards:** Create and engage in active partnerships to promote functionally defined technology standards across new and emerging platforms, thus accelerating deployment and achieving better outcomes.

4) **Leverage the relationships with relevant agencies within Commerce:** Make connections with sister agencies that can help NOAA's private partners to succeed.

The P3 Committee report is organized with a chapter describing each of these four areas. Each chapter includes a background section describing findings, recommendations for actions NOAA can undertake to improve implementation of P3s, and clarifying examples that illustrate how those recommendations can be, or in some cases have been, successfully implemented. By implementing these recommendations, the P3 Committee believes NOAA will foster more effective public-private partnerships.

Clarify NOAA's future directions

Findings

NOAA's mission is considerably larger than its current funding capacity, with this gap continuing to grow. Mission-aligned problems grow, complexity increases, data flow increases, environmental and social factors change rapidly, all adding further to complexity. Fortunately, the academic, private sector and NGO communities have been growing strong research, and technological and service capabilities that align with, and nicely compliment, NOAA's mission. For instance, mutually supportive roles have been developed between NOAA/NWS and the private sector weather forecasting community, resulting in one of the most successful weather enterprises in the world, one that delivers trusted products globally to both industry and citizens.

This collaborative model of working was made possible by first identifying the unique roles for each element of the public, private, and academic sectors, and then actively nurturing the relationships that enable joint planning and continued growth and responsiveness to changing needs.

Several other areas within NOAA's mission, such as Space Weather, Climate Services, Coastal Management, and Ocean Resource Management, are ripe for adopting this collaborative model. In the case of Space Weather, there are well-established academic and private sector players. In Climate Services, the field of private sector and NGO contributors is rapidly expanding and serving the evolving global needs. Furthermore, in Coastal Management, not only are academic, private sector and NGO entities involved, but local and state governments are active, as are private consultants and technology developers.

NOAA's Weather Water and Climate Strategy: FY23-27 acknowledges the importance of Strategic Partners, but it does not offer any information about how such partnerships will be built, and critically, how communication among the partners will be enabled. Plans may be well laid out and the directions may serve the country, but details on timing, spatial resolution of products, and delivery mechanisms are beyond the scope of this document. These details, however, are critical to investors, who must understand the potential value of their proposed

investments, and to innovators, who need to see a pathway to a viable market outlet for their work.

The primary desired outcomes of these recommendations are that NOAA will:

1. Learn from the success of the weather enterprise.
2. Work synergistically with private and academic partners to address critical needs while avoiding redundancies.
3. Clarify future NOAA directions so investors understand where untapped opportunities exist.

Recommendations

1. **Actively explore non-federal activities early in planning** to assure NOAA that it is not competing with the private sector in areas well covered by them. Increased awareness should save NOAA resources and assure that only unmet needs are prioritized for NOAA investments.

2. **Engage early with partners to share information and answer questions** in the private, academic, NGO, and local government spaces to make clear NOAA plans, which may clarify what is already written in Planning Documents. Recommended venues for these targeted communications include:

    - Routine/periodic public meetings in which NOAA describes future plans and articulates specifics and timelines along with scoping issues.
    - Annual formal statements of plans and technology needs by NOAA which include updates of previously shared plans.
    - Briefings at scientific, professional, academic society, and industry fora

These fora will be most useful if NOAA communicates specific activities, budgets, and timelines, to the extent that this information is appropriate (and legal) for sharing. NOAA should also seek out information to identify and confirm what is well-handled in the private sector to avoid duplication. For example, what is currently being done in coastal environments and what additional new solutions are needed in high and low energy coastal environments to stabilize climate-induced shoreline changes? Similarly, how might downscaled sensor networks, deployable at localized scales, help drive observations of ecological and hydrological health and accrue benefits to local decision makers?

The highly successful weather enterprise has indicated the need for more open future planning. Because of rapidly changing capabilities in the private sector for computing, observations, and forecast delivery, the community is eager for less adherence to rigid, previously defined roles, and is more in favor of more open planning and flexibility in meeting future needs. Other communities are likely to benefit from this more open, complementary planning as well.

Examples of how NOAA can improve overall outcomes
NOAA's 5-year Aquaculture Strategic Plan identifies one objective as: "Explore innovative approaches for fostering growth of early-stage aquaculture companies, new technologies for aquaculture production, and development of new products and customers (e.g., innovation incubators or accelerator programs)."

This is a good example of a NOAA plan that generally indicates intention and focus but has wording too vague to enable planning from the private and academic sectors. A private sector company may have a variety of questions such as, "What is the budget for this program?" "Are grants being considered as part of the innovative approaches?" "Will this include wild-catch or controlled farming?" "Will the scope include aquaculture-pollutant efforts?" Knowing these details is critical for an outside-NOAA entity in this space to understand before they can successfully do their own planning.

Two solutions to assure that NOAA and private sector entities respect each other's strengths and role are: 1) to have NOAA review private sector capabilities before embarking on new products and services, and 2) to support more communication from NOAA when it does expand its role to new products and services. Just as NOAA does not need to develop weather apps for phones because the private sector has this service well covered, NOAA may not need to embark on various climate and space weather services that are already covered by the private sector. NOAA's mission is better served, and resources better managed by having NOAA support expanding fundamental observations and developing foundational research models. These suggested solutions require more direct communication between NOAA and the private sector. These efforts will allow more efficient use of public funds as well as more able and nimble private sector activities.

Enhance a nurturing environment for fledgling technology

Findings
Public-private partnerships require several critical elements for successful engagement. These include: finding a receptive environment for generating and developing ideas and technologies; nurturing development of technology along the ideation and testing phases; and then seeing it into its deployment, whether in NOAA or to the market. The nurturing phase of P3 involves supporting the business model and relationships that can propel a technology or process into successful deployment, and without which innovative approaches too often wither away in the "valley of death." This nurturing of outside entities should be specifically linked to technologies and problems that align with NOAA's mission. On the one "generating-and-developing" hand, NOAA is a co-developer, and on the other "nurturing" hand, NOAA is a facilitator.

While NOAA has several investment and engagement mechanisms already in place, such as Memoranda of Understanding (MOUs), CRADAs, and Small Business Innovative Research (SBIR) programs to begin partnerships, these do not frequently address what happens after the initial

phase(s) of investigation or development conclude. In some cases, arrangements are akin to granting programs (flows of money), and others are partnership programs (resource sharing). Even given a successful initial development phase with NOAA support, after the project's close many technologies face the valley-of-death problem, leaving developers with a proven concept but no way to link up with or attract the next phases of capital needed for scale-up, manufacturing, marketing, and eventually sales. In some cases, NOAA may be a technology off-taker, but this should not be the sole goal. NOAA is not a market by itself, able to drive great P3 innovation. The goal of the successful P3 *relationship* should be to facilitate and enable technological development that addresses mission-aligned problems and that includes external market uptake and success as a key program evaluation factor.

NOAA could be a powerful partner in facilitating mission-aligned solutions that address not only technical development but also get the solutions out to solve NOAA needs, or to the market to solve pressing environmental and systemic challenges. Examples include small sensor development, autonomous systems, artificial intelligence (AI) interpretation / assessment of large complex data sets, satellite and related observational technologies for weather and environmental observation, and large computational capacity.

Recommendations

1. **Provide greater follow-through for innovative technology collaboration,** regardless of whether it is facilitated through an MOU, CRADA, SBIR investment or other mechanism**.** Good stewardship of these investments is critical to help bridge the "valley of death" and increase the successful deployment of the developed product or service, either with NOAA as an off-taker, or to non-NOAA entities that include the commercial marketplace.
    - NOAA should strive to remove specific barriers that prevent the use of commercial innovations supporting NOAA's mission. It's been mentioned that technologies developed in one line office may have difficulty in getting implemented or adopted in another line office.
    - NOAA should seek a mechanism like DARPA or ARPA (see example below), as a NOAA Technology Accelerator or NOAA Innovation Unit, to stimulate and drive an innovation ecosystem in areas of tech development that align with NOAA's mission. This institutional entity will require a commitment of staff and resources, modeled after successful DoD and other agency programs.

2. **Use Project Champions to create an environment of innovation and "ownership" of successful projects.**
    - Assign an agency focal point as a Project Champion for every P3 effort, regardless of the vehicle used. This person (acting with the project team and in combination with other such "navigators") would be an advocate for inclusion of private-sector technology in NOAA programs. They should develop (or be hired with/for) deep connection(s) to other federal and private market programs and entities.

- Make sure rewards for this role in annual evaluations and promotions are properly aligned. If this is just "extra work" then the likelihood of success diminishes.
- Project Champions should meet periodically (e.g., monthly) to share lessons, challenges and create stronger linkages to support innovation within NOAA.
- Support Project Champions with an "Innovation Steering Group" to help identify and guide innovation efforts, create innovation pathways, and assure project integrity.
- Have champions or navigators have a line of sight directly to senior management.

3. **Host periodic and routine regional or national sectoral workshops or meetings (like "Tech Bridges").** These gatherings would be places where companies and NOAA present their progress, successes, and challenges (subject to confidentiality interests) to high-level program staff, invited external partners, and potential next-stage investors. This will create additional line of sight between a developing technology and market potential either within NOAA or the federal government, or in the external marketplace.
    - Create sharing opportunities and fora where external investors, market actors (buyers) and others can learn about innovative and mission-aligned technology development. Finding the linkages and handoffs from the P3 engagements to the external environment presents innovation as a value chain from ideation to testing and proof of concept to scale-up to product development to adoption. NOAA has roles along the entire chain of innovation and can help with the requisite relationships and handoffs once the NOAA / P3 engagement has concluded.

4. **NOAA should pursue a substantial increase in fiscal capacity to stimulate technology development.** The need for NOAA to take a more active role in the nurturing phases of technology development is as much a cultural commitment and alignment of rewards for risk taking as it is a fiscal commitment. The two are intertwined.

- Explore streamlined Commercial Solutions Opening (CSO) where CSO seeks proposals for innovative, commercial technologies that accelerate attainment of NOAA capabilities.
- Explore greater use or expansion of "Other Transaction Authorities" (OTAs) to pursue flexible, innovative business arrangements and risk-sharing for technology advancement or prototypes.
- Pursue Small Business Investment Corporations with the U.S. Small Business Administration (SBA) to access low-cost, government-backed capital to invest in U.S. small businesses.

- Develop an annual process to identify and convey technology needs to the commercial sector, expanding beyond professional "academic" organizations to reach small business and industry.

Example of a mechanism to nurture innovation

One example of an innovation ecosystem is the Department of Defense Advanced Research Projects Agency (DARPA). For sixty years, DARPA has held to a singular and enduring mission: to make pivotal investments in breakthrough technologies for national security. The genesis of that mission dates to the launch of Sputnik in 1957, and a commitment that the U.S. would be the initiator and not the victim of strategic technological surprises. Working with innovators inside and outside of government, DARPA has repeatedly delivered, transforming revolutionary concepts and seeming impossibilities into practical capabilities, including game-changing military innovations such as precision weapons and stealth technology, but also icons of modern civilian society like the Internet, automated voice recognition and language translation, and Global Positioning System receivers small enough to embed in consumer devices. DARPA explicitly reaches for transformational change instead of incremental advances. It works within an innovation ecosystem that includes academic, industry and governmental partners, which work with DARPA to create new strategic opportunities and novel outcomes. For decades, this interlocking ecosystem of diverse collaborators has provided an innovative and nurturing environment for the intense creativity that DARPA is designed to cultivate.

DARPA also benefits greatly from special statutory hiring authorities and alternative contracting vehicles that allow the Agency to take quick advantage of opportunities to advance its mission. These legislated capabilities have helped DARPA continue to execute its mission effectively. Other DoD efforts include the Defense Innovation Unit with notable innovation success and processes.

Promote industry standardization

As a critical follow-on to innovation, technology development and proof of concept scale-up, standardization is essential for the widespread adoption of novel technologies. Measurements from sensors by different manufacturers and results from different laboratories (e.g., accuracy of spectral correction factors, wavelength dependency in measurement precision and accuracy within and between instruments, and differing data correction procedures) are hard to compare – or even relatively meaningless – unless there is standardization across providers, and non-standard communication protocols create information barriers.

Standardization and method development can be achieved using functional specifications, traceability to reference standards, and standard operating procedures (SOPs). A well-crafted set of functional/performance specifications can be used to optimize designs for product and service offerings by industry, resulting in economic and scientific benefit for all stakeholders.

NOAA often relies on outside parties for standardization, for instance:

- The World Meteorological Organization (WMO) collaborates with NOAA on standards for data exchange and many other areas to support weather forecasting.
- The National Institute of Standards and Technology (NIST) works with NOAA on calibration / accuracy of environmental sensors and instruments used in weather and climate research.
- The Open Geospatial Consortium (OGC) works with NOAA on interoperability and sharing of geospatial data used in weather and climate research and forecasting.
- The American National Standards Institute (ANSI) works with NOAA on issues related to climate and weather data standardization.

NOAA does well in coordinating its research with other federal agencies through, for example, the National Oceanographic Partnership Program, but it could do a better job with other entities. For example, most States have laboratory accreditation bodies that ensure method standardization and implement laboratory accreditation. States are often a key client for NOAA-developed technologies, but NOAA is not well-connected to these programs.

Standardization for some technologies is also achieved through industry trade organizations; non-government standards (NGSs) are developed, established, coordinated, and approved by private sector organizations with wide membership using a consensus process. However, the P3 Committee could not find examples of NOAA working in partnership with them to assure standardization, even in cases where NOAA provided early support of the technology development. Except when inconsistent with law or otherwise impractical, Section 12(d) of Public Law 104-113 requires that federal agencies use NGSs in lieu of government specifications and standards.

Recommendations: Technology Standardization and Performance Specifications

1. **Strengthen partnerships with other entities that will help standardize technologies and functional specifications in which NOAA has invested.** These avenues may be formal relationships, but they may also take the form of workshops that facilitate co-creation of SOPs and the requisite testing that proceeds SOP development. A balance needs to be sought, the goal being to facilitate adoption without unduly constraining the creative innovation of new methods, and adapting to ubiquitous technologies (e.g. internet/IoT, wireless communications) that can achieve NOAA's goals.

2. **Develop a programmatic approach for hand-offs**, particularly partnerships with States that have responsibility for standardization. Further partnerships with existing standards organizations that have the framework required to sustain and advance standards as the technologies evolve (e.g., ANSI, WMO, NIST, OGC). The Committee thinks this is a role that the project champions can help facilitate. NOAA should seek to be the trusted partner that facilitates collaboration among States/NGSs and method developers / manufacturers, rather than be responsible for creating the standard. NOAA is right for this role because they have clarity about use cases but are often not the final client or market buyer for the developers or providers.

The P3 Committee recognizes that determining the timing for when standardization is appropriate can be challenging. Pushing for standardization too early can stifle development, but failing to standardize methods and processes suppresses adoption. The solution is to focus on performance specifications and desired outcomes rather than on technical details. A key objective, particularly for emerging technologies, is to determine which aspects of the technology are crucial to performance and which are less important to the resulting measurements or predictions.

Example 1: Environmental DNA as a standardization success story in the making
NOAA is making large investments in measurement of environmental DNA (eDNA), in which biota can be tracked by measuring the genetic material they slough into the environment. eDNA holds the promise for assessing life in the aquatic environment in ways that were unimaginable just a decade before. The technology has matured to the point of critical scientific credibility, but there are many facets of the techniques and equipment that have not yet been fully standardized. Resource managers have expressed eager interest in the technology but have also expressed concern that researchers are still using a wide range of genetic markers and libraries in implementation, making it difficult to determine method repeatability. Compounding this challenge is that multiple federal agencies are investing in the technology using a range of different approaches.

NOAA can perform a mission-aligned service by helping to create a cohesive and standardized environment for this technology to flourish in federal, private, and not-for-profit use. This was seen by the P3 Committee as a critical aspect of supporting the entire innovation chain in the tech development cycle.

Recognizing the need at least for synchronization, if not for standardization, of methods, NOAA helped initiate two national eDNA workshops, one held in 2019 and the second in 2022. The first workshop served to enhance coordination among federal agencies, and with many of the academics that the federal agencies were funding. The second workshop enhanced participation to include equal participation by States, industry, and private foundations, all of which agreed that commercialization and adoption of this technology would require greater consistency than the present array of techniques. A working group was formed at the second workshop to determine how and what aspects to standardize. They concluded that the next logical step in standardization is a “bake-off” to determine how, and which aspects, of the varied techniques produce the greatest differences in results. Private foundations that see the potential for this technology have tentatively offered to help fund such a study, illustrating how a public-private partnership can advance technology. NOAA, in partnership with several other federal agencies, has agreed to host another workshop in 2024 to hear the outcomes of that study and discuss development of a national eDNA standard set of practices.

Example 2: Aviation Weather Observations standardization
Wind sensors have grown from technology that cleared the propwash of a DC-3 to multiple, expensive sensors for meteorological modeling serving large carriers, beyond the minimum

necessary for safety of flight. Specifically, only two metrics are required: 1) altimeter setting (reflecting local barometric pressure to determine runway height and 2) visibility. The current single standard, set jointly by the National Weather Service and Federal Aviation Administration, at large airports for major commercial carriers is physically unachievable in land acreage, airspace physical spacing is not affordable for 4,500 private use airports, and 14,000 private airfields. NWS and FAA have also removed eligibility of private sector weather observation systems from federal funding assistance through the Airports Improvement Program (AIP). These same private sector systems are used internationally for military and civilian use, without such restrictions. The basis for prohibition is unclear as NWS surface weather observations specifically allow use of observations from multiple sources, without technical standards (Figure 1) and without requiring approval of every change made within private sector products and services or requiring the use of federal personnel in every phase of installation, activation, enhancements, and maintenance. Current NWS/FAA denials in the US marketplace for use of private investments in aviation weather systems and data provision or dissemination through the National Weather System (NADIN/WMSCR) discourages further investment, innovation, and collaborative efforts to support NOAA's mission. The NWS and FAA should work with the private sector to enable safe and effective access.

Table 5-1. Estimating Wind Speed

Knots	Specification	Knots	Specification
<1	Calm; smoke rises vertically.	22-27	Large branches in motion; whistling heard in overhead wires; umbrellas used with difficulty.
1-3	Direction of wind shown by smoke drift not by wind vanes.	28-33	Whole trees in motion; inconvenience felt walking against wind.
4-6	Wind felt on face; leaves rustle; vanes moved by wind.	34-40	Breaks twigs off trees; impedes progress.
7-10	Leaves and small twigs in constant motion; wind extends light flag.	41-47	Slight structural damage occurs.
11-16	Raises dust, loose paper; small branches moved.	48-55	Trees uprooted; considerable damage occurs.
17-21	Small trees in leaf begin to sway; crested wavelets form on inland waters.	56-71	Widespread damage.

Figure 1. Table from Surface Weather Observations and Reports FCM-H1-2019

Leverage relationships with relevant agencies within Commerce

Findings
NOAA resides within the Department of Commerce, which provides unique opportunities to facilitate Public-Private partnerships. Several sister agencies within the Department have missions to encourage private industry and NOAA can help make connections that will assist their private partners succeed. The Committee explored some of those opportunities by interviewing representatives from other Department of Commerce agencies, asking how they presently interact with NOAA and what opportunities they feel NOAA can take advantage of. The descriptions below capture some of those opportunities, though it is not intended to be comprehensive or prescriptive. Instead, it focuses on illustrating opportunities that NOAA can explore.

Economic Development Administration
One recommendation from this report is to nurture external research or technology development beyond the initial investment phase. The Economic Development Administration EDA can help with that since one of their goals is to support innovation and technology transfer to enhance economic competitiveness. NOAA, with its focus on environmental science and technology, could collaborate with private companies through EDA programs to transfer technology, promote research, and spur innovation in areas like climate monitoring, weather forecasting, and marine resource management.

For instance, NOAA's aquaculture programs aim to promote sustainable marine farming. Collaboration with EDA can create economic development programs that support the growth of the aquaculture industry, including funding for infrastructure and workforce development. EDA offers several programs that NOAA can leverage to help their private partners. These programs offer coaching, such as technological acceleration programs and educating innovators about the value chain of their products. They also can offer office space, networking opportunities, and access to resources that can help innovators refine their business models and attract investment.

EDA also provides direct funding for innovators. While the focus of this report is on non-financial support from NOAA, it does include facilitating collaborators finding other funding mechanisms outside of NOAA. EDA's Build-to-Scale grants are one of those mechanisms that can help innovators pass through the valley of death. In particular, the EDA's Venture Challenge funds entrepreneurial support organizations to support ecosystems that create the next generation of globally competitive, industry-leading companies. The Venture Challenge offers three types of grants—Build, Scale, and Ignite—designed for grantees to implement programming that reflects the maturity and capacity of their respective innovation and entrepreneurial ecosystems. NOAA can help guide their partners into these plans.

EDA has also maintained an Industry Challenge program in the past in which it partners with other federal agencies to support entrepreneurship and accelerate company growth within

certain sectors. In 2020, that focus was on the Blue Economy. NOAA can partner with EDA in that program to enhance similar future opportunities.

National Institute of Standards and Technology (NIST)

Another report recommendation is to help standardize technology so as to create a stable marketplace in which new technology can flourish. One of NIST's focal roles is to create reference materials and calibration approaches that are core to standardization. NIST needs a clearer understanding from NOAA on what technologies are in development and which they should be supporting. The two agencies could work together on development of standards related to environmental monitoring equipment, data interoperability, or manufacturing processes.

In addition, NIST maintains the Manufacturing Extension Partnership (MEP), which is intended to help innovators scale from pilot to demonstration, helping transition past the valley of death for new technology. MEP centers can provide technical assistance and expertise in manufacturing processes, materials, and technology. This support can include optimizing supply chains, ensuring that the components and materials required for ocean technology development are sourced efficiently and cost-effectively. MEP can also assist companies in implementing and improving quality management systems, ensuring that the manufacturing processes for ocean technology products meet industry standards and regulations.

NIST is a logical partner for NOAA as it has a history of successful P3 investments, with the greenhouse gas (GHG) monitoring program being a good example. Quantification of greenhouse gases previously used bottom-up measurement techniques (emissions factors and fuel usage), with no requirement or capability to do top-down verification or attribution through in situ sensing networks and inverse modeling frameworks. To advance verification capacity, NIST's Urban Domes project was established, comprising multiple testbeds in several geographies and climate regimes (LA Basin, Northeast Corridor, Indianapolis). The project incorporated governmental support, academic institutions with advanced prototypes, and private sector participation bringing real world capabilities to combine into a cohesive effort. The project required multiple contract vehicle types given the diversity of participating entities. The agreements began with Measurement Science and Engineering Research Grants to The Pennsylvania State University in 2010 and Scripps Institution of Oceanography at UC San Diego in 2012. Earth Networks (today part of Advanced Environmental Monitoring, AEM) along with other academic and private sector organizations was a collaborator on these initial awards. At the same time, a CRADA between NIST and Earth Networks for related activities was established. This P3 collaboration enabled the researchers to test theory in pseudo-operational environments and enabled the private sector to demonstrate what it will take to fully operationalize and potentially commercialize the capabilities. The P3 collaboration enabled NIST to provide global leadership, advancing the science and systems required to better address future GHG policy decisions.

US Patent and Trademark Office (USPTO)

One of the challenges in transitioning new technology into application is protecting creativity through the patent process. Many of NOAA's research partners are small fledgling businesses or individual researchers that have limited familiarity with the patent process. Moreover, they may not even recognize that initiating the patent process early in development can be preferable to waiting until the technology is fully-fledged and vulnerable to adoption by other entities.

NOAA can connect their partners with USPTO's Office of Innovation Outreach, which exists to educate people about how and when to file a patent application. That office can connect them with the broad range of free resources that the USPTO offers to help innovators learn about intellectual property and navigate the patent application process. The USPTO can also provide connections to a network of independently operated regional programs that offer pro bono legal services for qualifying inventors and small business owners. The key here is training, both for the partners, but also with NOAA researchers and grant managers so they know when and how to advise the partners about the opportunities.

Seizing this opportunity should be readily achievable because there is history of successful partnership between NOAA and USPTO. For the past year, USPTO and NOAA have successfully engaged in a work-sharing program, wherein USPTO provided NOAA with intellectual property expertise in the context of technology transfer, while NOAA provided USPTO with critical climate expertise. This exchange produced a customized intellectual property training program for NOAA employees, which is currently underway and has had positive early results.

Implementation

Taking advantage of these opportunities will require commitment beyond NOAA, needing encouragement and facilitation at the Departmental level. However, the representatives from sister agencies all saw opportunities that would be of mutual benefit in achieving their respective missions. This collaborative investment can pay dividends for NOAA and for the Department as a whole, allowing them each to achieve their mission better than they could alone.

Conclusion

These recommendations aim to foster an innovative environment within NOAA that creates strong partnerships with external entities, with the result of bringing new technologies and solutions to NOAA and to the market where they align with NOAA's mission.

As the lead federal agency with its operational mission in these areas, NOAA can and should enable a robust industry that complements NOAA's services and extends the value of NOAA's science, data, and services by being even more communicative about their plans for future efforts. Similarly, NOAA may find the plans of their partners in these areas useful for NOAA's prioritization of investments.

NOAA's plans may overlap directly with activities in the private sector. Just as there is no need for NOAA to create weather apps for mobile phones because they are well-developed and well-supplied by the private sector, there is no need for NOAA to duplicate climate risk products which are currently developed and well-supplied by NGOs or provided by the private sector.

It was an honor and a great learning experience for the P3 Committee members to speak with some NOAA leaders, sister agencies in Commerce and private industry in generating these recommendations. The Committee saw passion and a mission-based mindset to serve the complex and broad communities to whom they support on natural resource, environmental, informational, social, and economic problems. The very breadth of responsibilities can make the work difficult, and, at times, easy to segment or silo. The P3 Committee observed across the NOAA representatives interviewed a deep desire to engage broadly and drive solutions forward.

Appendices

Appendix A: Committee Members

Steve Weisberg, P3 committee primary co-chair - NOAA Science Advisory Board
Jon Allan, P3 committee co-chair - NOAA Science Advisory Board
Elizabeth Weatherhead, P3 committee co-chair - NOAA Science Advisory Board emeritus
Ilene Carpenter, P3 committee member - NOAA Science Advisory Board
Ilse Gayl, P3 committee member - NOAA SAB Environmental Information Services WG
David Grimes, P3 committee member - NOAA Science Advisory Board
Anthony Wu, P3 committee member - NOAA Science Advisory Board

Appendix B: List of Those Interviewed

The NOAA Science Advisory Board P3 Committee would like to thank the following individuals for their formal presentations and discussions with the P3 Committee:

Michael Schulte, Advanced Micro Devices, Inc.
Devin Bohanan, Department of Defense APFIT
Erica Jeudy, Department of Defense APFIT
Andrew Chappell, Department of Defense APFIT
Amanda Kosty, Economic Development Administration
Sinjav Sinha, Environmental Consulting & Technology, Inc.
Jyoti Malhotra, National Institute of Standards and Technology
Jose Colucci, National Institute of Standards and Technology
Marlon Walker, National Institute of Standards and Technology
James Whetstone, National Institute of Standards and Technology
Sarah Kapnick, NOAA Chief Scientist
Frank Indiviglio, NOAA Chief Technology Officer
Wayne MacKenzie, NOAA Technology Partnerships Office
Genevieve Lind, NOAA Technology Partnerships Office
Dave Wartofsky, Potomac Aviation Technology
Matthew Armsby, Resources Legacy Fund
Kaitlin Gaffney, Resources Legacy Fund
Kevin Petty, formerly of Spire
Michael Jones, SubSeaSail
Aaron Snyder, United States Army Corps of Engineers
Adele Braun, United States Army Corps of Engineers
Nate Campbell, United States Army Corps of Engineers
Kevin Denn, United States Army Corps of Engineers
Laura Witherow, United States Army Corps of Engineers
Parikha Mehta, United States Patent and Trademark Office
Matthew Shed, United States Patent and Trademark Office
Neil Jacobs, University Corporation for Atmospheric Research

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Rich Sorkin, Jupiter Intelligence; Dan Stillman, Tomorrow.io; Scott Rayder, Leidos; Jonathan Porter, AccuWeather

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Appendix C: Bibliography

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